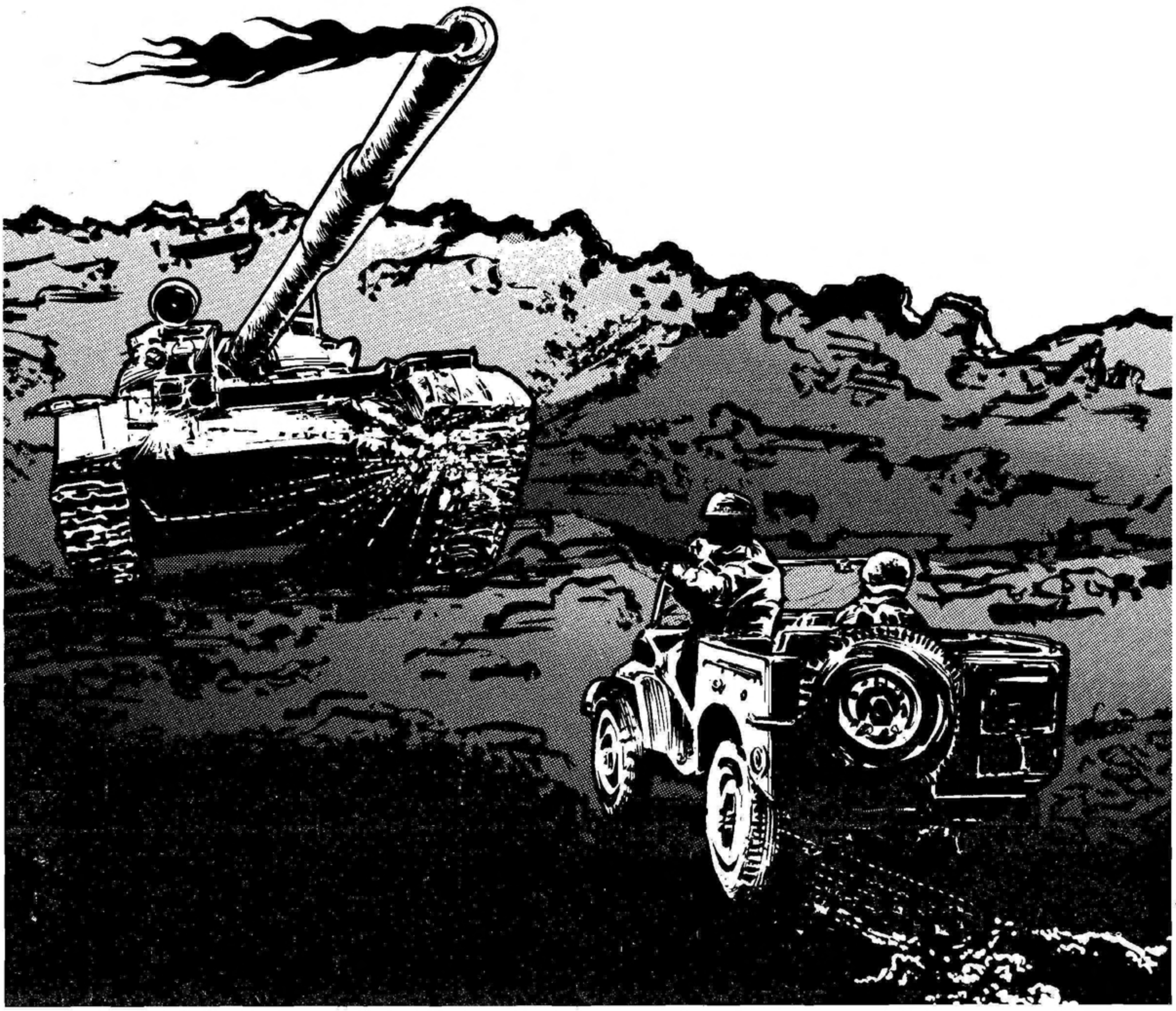
ARMOR....
....ATTACK



OPERATION AND MAINTENANCE

MANUAL

CINEMATRONICS, INC.
1150 BILLY MITCHELL DRIVE
EL CAJON, CA 92020

TELEX: CINEMAT 697891

CALL TOLL FREE: 800 854-6577

IN CALIFORNIA CALL: 714-440-2933

SALES: 8-5 (PST) WEEKDAYS

SERVICE: 8-5 (PST) WEEKDAYS

CINEMATRONICS INC.
ARMOR ATTACK

WARNING:

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction's manual, may cause interference to radio communication. As temporarily permitted by regulation it has not been tested for compliance persuant to Subpart J of part 15 of FCC rules, which is designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

TABLE OF CONTENTS

PART ONE
Information for Operators

PART TWO
Information for Technicians

APPENDIX A

PURPOSE AND LIMITATIONS OF THIS MANUAL

This manual cannot and does not replace technical expertise. Should out of warranty repair be necessary, we suggest the operator protect his/her investment by hiring an experienced, competent technician (preferably with some knowledge of the Vectorbeam tm Monitor). We have seen many examples come into the factory of incompetent repair creating many more problems than originally existed. One common fault is incorrect substitution of parts. Another is damaged foil traces on PC boards. Repairing broken foil is time consuming and therefore costly.

This manual has 2 major purposes, and is correspondingly separated into 2 major parts.

Part one of the manual contains information operators need to know. It has been written to tell people who have little or no technical knowledge what they should know about this game, without getting technical. Part one contains valuable information about the Armor Attack Game, receiving inspection and installation, an introduction to the major electronic sections of the game, and an operators guide to trouble shooting — finding the source of a problem with a minimum of technical jargon.

If you need more assistance than this manual can give call Cinematronics' Customer Service Department at our toll free number.

Part II of this manual is designed to help the qualified technician understand the functions of the various circuits in the game, and quickly troubleshoot any problems. Part II contains Theory of Operation, Trouble shooting Procedures, Schematic and Wiring Diagrams, Layout Drawings, Parts List, and suggested test equipment. If you need further assistance, please call Cinematronics' Customer Service Department at the toll free number.

WARRANTY

Cinematronics, Inc. warrants the goods to be free from defects in material and workmanship under normal use and service for a period of ninety (90) days from the date of shipment from factory. Cinematronics makes no representation or warranties concerning the goods whether express or implied by operation of law or otherwise, including those of merchantability or fitness for any particular purpose, or with respect of patent infringement, except as may be specifically made herein. Cinematronics limits its warranty obligations herein to the repair or replacement of such parts which have been returned to Cinematronics' plant at purchaser's expense and which examination shall disclose to Cinematronics' satisfaction to have been so defective and to the shipment of such repaired or replacement parts to the purchaser F.O.B. the shipping point.

This warranty does not apply to any Cinematronics product which has been altered or repaired by unauthorized personnel or service facilities or any products which have had the unit serial number altered or removed.

Upon acceptance of the goods, the purchaser agrees to assume all liability for damages and/or bodily injury by the purchaser or any other person and to hold Cinematronics, Inc. harmless from liability or claims arising from the use of the goods by any person. Purchaser further agrees to indemnify Cinematronics, Inc. from any liability, claim, cause of action or litigation resulting from the use or misuse of the goods by any person.

Parts returned for warranty service must be packaged so that no damage is incurred during the shipment. Full documentation and instructions must accompany returned parts. Parts must be shipped prepaid to:

Cinematronics, Inc.
1150 Billy Mitchell Drive
El Cajon, CA 92020

CUSTOMER SERVICE PROCEDURES

FOR AUTHORIZED CINEMATRONICS' DISTRIBUTORS

It is the desire of Cinematronics, Inc. to provide efficient and courteous service should the need arise. We have a fully staffed Customer Service Department and encourage you to call our toll free number: 800-854-6577,78, for technical assistance between the hours of 8:00 A.M. and 5:00 P.M., California time, Monday through Friday.

In order to provide the very best service possible, the following procedures for ordering or returning parts must be followed:

1. All equipment ordered from Customer Service, whether in or out of Warranty, must be placed with a Distributor's purchase order, either by mail or verbally by telephone.

2. Advance replacement items may be obtained only during the term of the Warranty and when such items are available, using the same procedure as when ordering parts. When ordering a PCB, please include with your order the game serial number and the number of the PCB you wish replaced.

3. All items received as advance replacements will, after a period of thirty (30) days, become the property of the Distributor, with applicable charges applied in the event Customer Service has not received the defective item against which the advance replacement was made.

4. The Distributor must call this facility for an RMA number prior to returning any item. Please be prepared to provide us with the game serial number and the PCB number when requesting an RMA.

5. In all situations covered above, and in all other situations, the Warranty offered by Cinematronics, Inc. is applicable and should be fully understood.

6. Parts returned for service must be packaged so that no damage is incurred during the shipment. Cartons without a prominently displayed RMA number will not be accepted. Full documentation including game serial number. PCB number and reason for return must accompany parts. Ship prepaid to:

Cinematronics, Inc.
Customer Service Department
1150 Billy Mitchell Drive
El Cajon, CA 92020

800-854-6577 714-440-2933

PART ONE

Information for Operators

SECTION 1

HOW TO PLAY ARMOR ATTACK

INTRODUCTION

Armor Attack is a one or two player Battle-Action game, with features geared for maximum player appeal: unsurpassed realism (functional tank treads, turret recoil, burning debris, ''War Zone'' audio) and progressive levels of difficulty. The game adjusts itself to the skill of player, e.g., if you're skilled, it plays harder.

GAME PLAY

The play field is a top view of a city with road and building areas defined. Players (jeeps) and enemy (tanks) can only manuver on the roads, however the enemy chopper can go over buildings and roads. Whenever the player shoots and hits the side of the building the missile explodes. The shots are only valid over road areas. Debris left by tanks is not self-destructive and can be driven around.

The object of Armor Attack is to accumulate the maximum number of points possible. This is done by shooting tanks and/or choppers. (Shooting other player in a two player game does not count.) The player must also avoid being shot by either the tank or chopper. If the player shoots a chopper, the bonus level is incremented by 10 points. When the fifth chopper is destroyed an extra jeep is awarded (Bonus Level +10, +20, +30, +40, extra jeep). The players turn is over when he gets shot by the tank or the chopper. In a two player game, the round is not over until both players are shot. The number of rounds per game is set by the operator. Points are awarded as follows:

1. SHOOTING TANKS

20 Points is scored for hitting the body of the tank (first hit)

30 Points is scored for hitting the turrets (second hit)

The Bonus Level is also awarded for hitting the turrets (the Bonus Level of 0- 40 is determined by the number of choppers destroyed.)

2. SHOOTING CHOPPERS

100 Points is scored for shooting a chopper. The Bonus Level is also incremented.

MODES OF PLAY

There are two modes of play in Armor Attack 1) The one player mode; and 2) The two player mode

One player mode is selected by inserting coin or coins and depressing the one player start button. The player (jeep) will appear in the center of the screen and flash until one of the player control buttons (left, right, forward and fire) is depressed. The player then uses the left, right and forward buttons to manuver the jeep around the screen. If a player runs into a wall he will merely stop or slow down but no damage will occur. When a player is pointed at a target, pressing the fire button will launch a missile. A maximum of 2 missiles is allowed for a player at any given time.

The player can be destroyed three ways;
1) If a player is shot by a tank
2) If a player is shot by a chopper
3) If a player is run over by a tank

The number of times a player can be destroyed is determined by the number of jeeps per game selected on the 7-position option switch on the logic board.

If a player shoots a tank once, there is a time limit to shoot the turret. If the player does not shoot the turret, it will explode automatically and no points will be awarded.

TWO PLAYER MODE

The two player mode is selected by inserting coins and depressing the two player start. Both players jeeps will flash (to draw attention to them) until a player control button is pressed. Start buttons will have no effect during the play of the game. The players cannot shoot each other. The rest of the play is the same as a one player game except for the following exception:

If one player is destroyed, the next round will not begin until both have been destroyed.

Good Shooting

SECTION 2

RECEIVING AND INSTALLATING ARMOR ATTACK

RECEIVING INSPECTION

Your game was shipped in ready-to-play condition. However, after removal of the shipping carton, a brief visual examination is suggested.

Naturally, you'll want to make note of any physical damage to the game cabinet and its external components for freight claim purposes. Considering the quality of the shipping carton, any damage to the exterior would indicate possible interior damage as well.

The interior of the game should also undergo a brief examination for: loose mounting hardware (check to be sure that the major components are still securely mounted); disconnected or loose wires, cables or harnesses; electronic devices loose in their sockets; etc.

At this time the game serial number should be logged. Please remember that the game serial number will be required if you need service from your distributor.

ELECTRICAL REQUIREMENTS

Unless specified otherwise, your game was shipped to operate at 115 VAC, 50/60 Hz. Two other voltage settings are possible. The power supply chassis has a table which shows the voltage options and fusing requirements.

A good earth ground is essential for the proper operation of this game or for that matter any electronic device. Problems with instability and erratic operation of computer-type devices can usually be traced to an ineffective ground system. Therefore, plug the game into a properly wired 3 prong outlet. If a 3 prong to 2 prong AC adaptor must be used, an alternate method of grounding the third prong must be used.

INITIAL ADJUSTMENTS

NOTE

When the game is connected to AC power, one of the game sounds may be heard. This is normal.

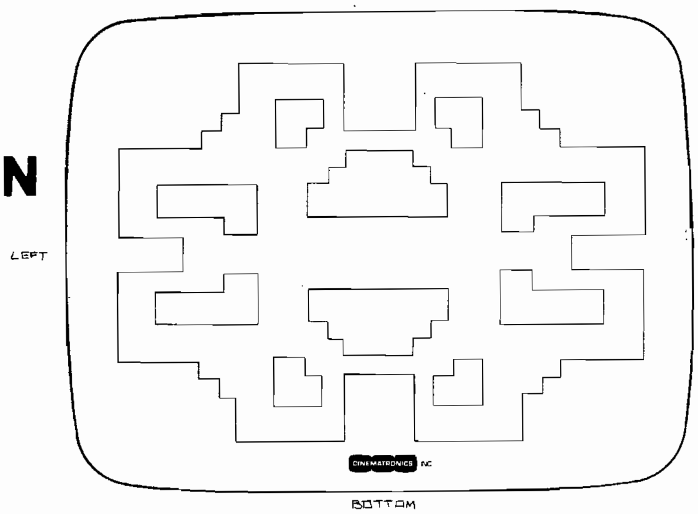
The audio level (volume) can be easily adjusted and THIS IS ACHIEVED BY ROTATION OF THE VOLUME POT LOCATED ON THE COIN DOOR. The audio level should compete with other machines "on the floor" to maximize play time.

Display brightness is another easy adjustment. The monitor assembly has several adjustments, but the brightness control is the only one which does not require a "screwdriver" for rotation. Keep the brightness at the correct level for appeal.

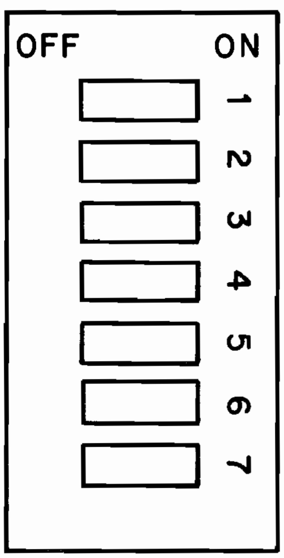
OPERATOR OPTIONS

The option switches allow you to select how many ships per game, how many coins per credit, and a test pattern for the Vectorbeam monitor. The option switch is located on the logic or game board. It is not necessary to remove the board from the cabinet to set the options. In fact, the option switch and audio control can be reached easily through the coin door opening. Table 2-1 will assist you with your selections:

TEST PATTERN



ARMOR ATTACK OPTION SWITCHES
LOCATED ON LOGIC BOARD
AT POSITION E-2



JEEPS PER GAME
SEE TABLE ONE

CREDITS PER GAME
SEE TABLE TWO

SOUND IN ATTRACT MODE: ON: SOUND
OFF: NO SOUND

NOT USED

DIAGNOSTIC — ON: NORMAL PLAY
OFF: TEST PATTERN

TABLE ONE

SWITCH 1	SWITCH 2	JEEPS PER GAME
OFF	OFF	5
OFF	ON	4
ON	OFF	3
ON	ON	2

TABLE TWO

SWITCH 3	SWITCH 4	CREDITS PER COIN
OFF	OFF	1/1
OFF	ON	1/2
ON	OFF	3/2
ON	ON	3/4

SECTION 3

GENERAL INFORMATION AND PERIODIC MAINTENANCE

Your Cinematronics game is designed much the same as conventional video games. The major exception is the use of an alternate means of visual display ... the patented Vectorbeam tm* monitoring system. However, the game is built of the same basic building blocks as any other video game.

The Power Supply provides all the necessary voltages for the CPU board, audio board, Vectorbeam monitor, and flourescent light. As you look in the back of the cabinet, it is located on the lower left side of the cabinet. The power supply has two circuit breakers, and a 3 ampere sloblo fuse. If one circuit breaker trips, the other breaker will soon follow. Always unplug the game before replacing the fuse or resetting the circuit breakers. If you need to replace the fuse use only a 3 amp. slo-blo fuse. The power supply also has a line voltage select switch that must be set to match the voltage in your area. There is also an adjustment for the +5 volt section. DO NOT ADJUST unless you use a volt meter and follow the procedure in Section 6. If needed, this power supply is directly interchangeable with the power supplies used in previous Cinematronics games.

The Central Processing Unit (CPU) is the "brain" of the game. As you look in the back of the cabinet it is the large PC (printed circuit) board on the right side. It "senses" when a coin is dropped in the coin slot, operates the coin meter, and gives credit. It then "reads" what is happening at the operator controls, interprets and computes to make the game play according to what buttons the player pushes. It tells the Vectorbeam monitor what to draw on the screen, and it tells the audio board when to make the appropriate sound effect. The CPU has a red LED (light-emitting diode), near the Molex power plug. This LED normally flashes once when power is turned on, then stays off. More on this in Section 6.

The Audio Board generates all the sound effects for the game and powers the loudspeaker. As you look in the back of the cabinet, it is the smaller PC board on the right side, just below the CPU.

The Vectorbeam tm* Monitor is the picture tube and associated "Monitor Board". It draws pictures on the picture tube screen according to the instructions it receives from the CPU. If it does not receive correct data from the CPU, it will pop the circuit breakers. The only operator adjustment here is the brightness control (See Display P.C.B. Connectors and Adjustments, pg. A13. For test purposes (e.g. to check the CPU), the Armor Attack monitor can be replaced by any previous Cinematronics monitor, except Sundance.

The Vectorbeam tm* Monitor is a completely different system from the standard raster-type monitor. Two advantages to this monitor are:

1. circuitry is simplified, and
2. ability to draw fine detail in the picture far surpasses conventional monitors, adding interest to the game.

If your monitor should need repair in the future, the technician should be familiar with the Vectorbeam monitor, because it is so different from the conventional raster system.

Interconnecting Cables are of 2 types: The Main Wiring Harness, and the Ribbon Connectors.

The Main Wiring Harness carries power from the power supply to the CPU, audio board, and monitor. It connects to each unit

through the Molex plugs. The Molex plugs are built so they can only plug in the right way. NEVER CONNECT OR DISCONNECT THE MOLEX POWER PLUGS UNLESS THE GAME IS UNPLUGGED.

The Ribbon Connectors carry data to and from the CPU. Since they can plug in two different ways, care should be taken to plug them in correctly. For the CPU, the ribbons are plugged in correctly if the ribbon is naturally directed away from the board (See Universal Bench Test Configuration, pg. 7-3). The ribbon at the monitor should also be directed away from the board. (See Universal Bench Test Configuration, pg. 7-3). The audio board is different: the ribbon should go up across the audio board. (See Universal Bench Test Configuration, pg. 7-3).

PERIODIC MAINTENANCE

The only Periodic Maintenance required is an occasional cleaning. The very high voltage used on the picture tube attracts dust that gradually degrades picture quality. To clean: unplug game and let sit for at least 5 minutes to let voltages "bleed-off."

The monitor is mounted in the cabinet on brackets. Remove the top bolt from each bracket and gently lower the monitor. Now you can clean the face of the picture tube, and the plexiglass cover. A mild solution of dish detergent will clean the plexiglass without harming the color decal. Care should be taken to not rub the decal, as it may be brittle with age.

SECTION 4

OPERATOR'S GUIDE TO TROUBLESHOOTING

or

How do I Figure out Which Board
to Send Out for Repair?

O.K. - this is where we get technical on you - but don't panic! We'll keep this as simple as possible so you can figure out which board to send out for repair. For some of the steps in this section you will need a simple VOM, and know how to use it.

Here are two important procedures we will refer back to in this section:

Checking the LED :

Whenever there is a problem with the game, a good place to check first is the LED (light-emitting diode) on the CPU board near the Molex power plug. This LED indicates whether most of the CPU circuit is working. When everything works right, here's what happens: Power to the game is turned on, the LED flashes on, then stays off. If the LED is flickering or on continuously, there is a problem with the CPU or the +5 volt supply. Check +5 volts on the logic board (follow procedures in this section). If the +5 is O.K., have CPU repaired.

Checking the +5 Volt Supply:

To check the +5 volts, you need a voltmeter. Turn power on in the game. Notice on the upper corner of the logic board nearest you is a little pin marked gnd. This is a great place to put the negative probe of the voltmeter. Near this pin in position T13 (see CPU layout, pg. A-8) is a 20 pin IC marked 74LS377. Ignore the other numbers on this chip. We can measure the +5 volt supply at pin 20. Pin 20 is the bottom pin on the far side of the chip. Put your positive probe there, without touching any other pins, and you should get a reading. Anything between +4.8 volts and +5.1 volts is o.k., otherwise, adjust the voltage.

The adjustment is located on the power supply, and it is the only screwdriver adjustment on the power supply. Adjust slowly WHILE READING THE VOLTAGE. Too much voltage will destroy IC's fast. If voltage cannot be adjusted into the correct range (+4.8 - +5.1 volts), repair power supply.

The following is a guide compiled from experience. It cannot be right 100% of the time:

SYMPTOM	WHAT TO DO
Circuit breakers trip	1. Unplug game. Unplug Molex power plug from monitor and reset breakers. Turn POWER ON. If breakers trip: POWER OFF, see 2. If breakers don't trip: Coin-up game and "play" it. Are all sound effects normal? Yes - repair monitor. No - Problem is probably in CPU or power supply. Check LED on CPU. Check +5 volts on CPU (see procedure) If +5 volts is good, repair CPU. 2. Unplug Molex power connector from audio board, reset breakers and turn POWER ON. If breakers trip: Problem is in coin meter circuit or call factory for help. If breakers don't trip: Repair audio board. POWER OFF, reconnect molex plug to monitor. Turn power on to see if there is a good picture. If the picture is bad, problem is probably in the monitor. If breakers trip: Check LED and +5 volt supply. If LED and +5 volts is O.K., problem is probably in monitor.

PART TWO

Information for Technicians

SECTION 5

VECTOR THEORY

In order to understand the basic concept behind a vector generated display, it is important to have a basic knowledge of vector theory.

In the vector display system, there are no horizontal and vertical lines (no sweep) or sync. A line generated using a vector system is shown in Figure 5-1.

A line is drawn by programming a beginning and ending point of the line to be drawn, and forcing the cathode beam to travel between these two points, illuminating the entire path on the screen of the CRT. The angle of the line, the position of the line, and the length of the line are determined simultaneously, and simply, by selecting the proper voltage levels for the beginning and ending points of the line.

This is accomplished by the two twelve-bit codes (words) applied to the DAC-80s on the display board. The DAC-80 will produce a different voltage level at its output for each possible combination of input bits (of which there are 4096 possibilities for a 12 bit word.)

It is also important to remember the function of the LF 13331 analog switch and its output RC network. Because we are dealing with reactive components in C101 and C201 on the display board the charging voltages found are non-linear by nature. (See figure 5-2).

Therefore, when a line appears on the CRT, it is actually only part of the entire path taken between the beginning and ending points of the vector (C-D). The section of A-B is chosen as the most linear portion of the charge curve, and is illuminated.

Sections C-A and B-D are blanked at the cathode and section A-B illuminated by controlling IC7 (7406) on the display board. These calculations are all performed on the CPU logic board.

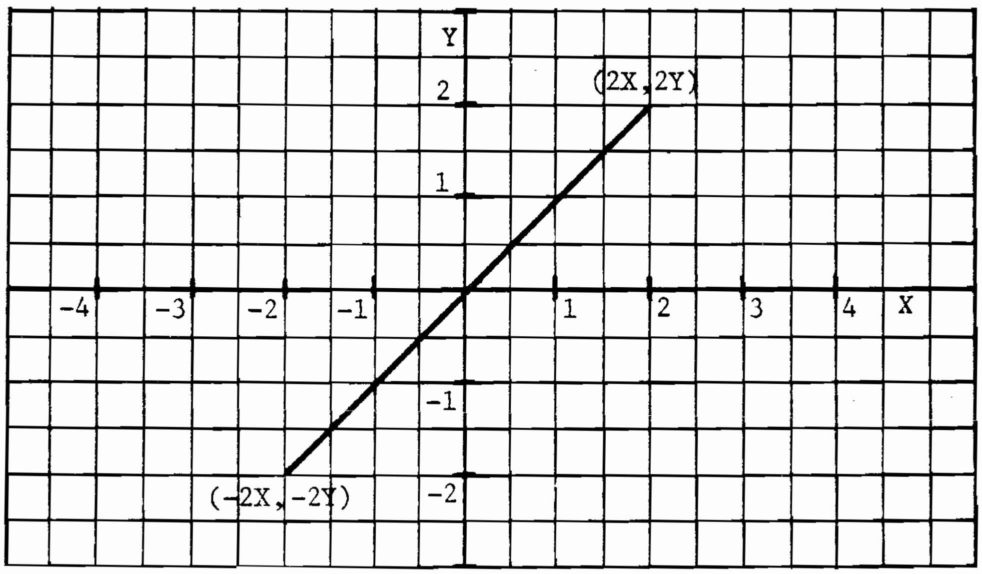


Figure 5-1. Line using Vector System

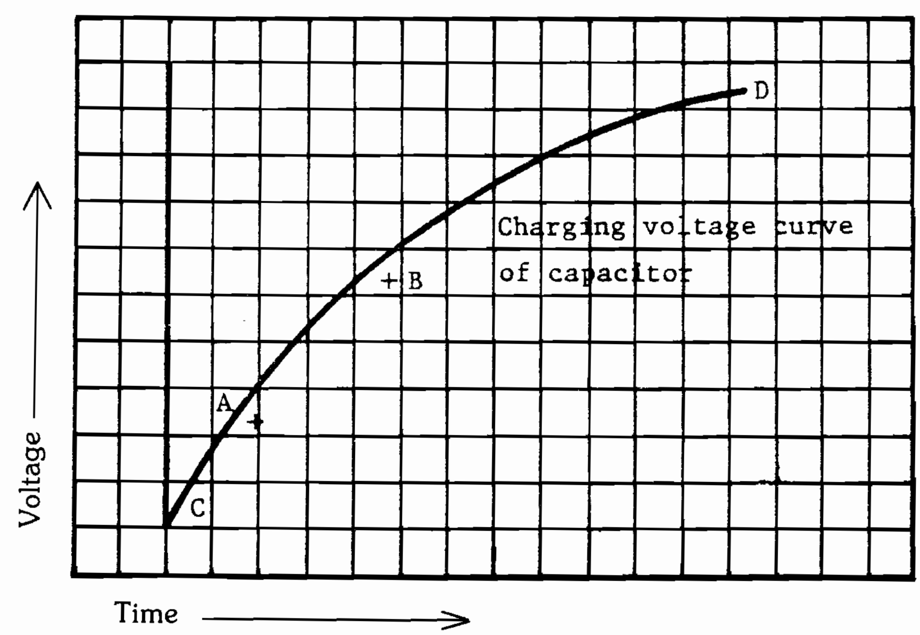


Figure 5-2. Non-linear Charging Voltages

When a line appears on the CRT, it is actually only part (section A-B), of the entire path taken between the beginning and ending points of the vector (section C-D). Section A-B is chosen as the most linear portion of the charge curve, and illuminated.

SECTION 6

THEORY OF OPERATION

GENERAL DESCRIPTION

This section describes the principles of operation of the major circuit functions of the Cinematronics Video Game. The system's general functional description is followed by detailed circuit schematics which are included as Appendix A. The schematics used in this manual are similar in nature to those used by most industrial electronic firms.

A. MONITOR

The Vectorbeam tm* Monitor is unlike the conventional TV monitor in that it displays vectors (lines) generated from X-Y coordinates received from the logic board. The horizontal points are X (width) and the vertical points are Y (height). The X and Y logic signals originate from the logic board.

The Vectorbeam tm* Monitor circuitry is so different from a raster scan monitor, it is useless to try to troubleshoot it using raster T.V. theory. The Vectorbeam tm* Monitor has no horizontal oscillator, no vertical oscillator, no AFC, no sync circuits, and no video amplifiers. How, then, does it work?

The Vectorbeam tm* Monitor can be divided into 4 main sections: voltage regulators; deflection circuits; video high voltage module; and brightness circuit (cathode drive).

There are three voltage regulators on the monitor board: +15v, -15v, +5v. Note that these are IC's, not transistors. The plus and minus 15 volt regulators supply both DAC-80's, the LF13331 analog switch, and the TL081 op amps. The +5 volt regulator supplies both DAC-80's and the 7406 (IC7). It takes little time and is well worthwhile to check all 3 regulator outputs every time the monitor is serviced.

Drawing a line requires two separate steps.

STEP 1. Digital information, in the form of a 12 bit word is applied to the input (pins 1 thru 12) of the DAC-80. Pin 1 receives the most significant bit, and pin 12 the least significant. The DAC-80 converts the digital word into an analog voltage which is outputted on pin 15. This voltage can swing between ± 5 volts, depending on the input word. The output of pin 15 then goes through a current limiting resistor R130 to the inputs of the analog switch IC1. (Pin 18 of the DAC-80 is an input for feedback). Now the CPU sends out an Initial Position pulse, closing the appropriate "switch" (actually a J-FET), to let the analog voltage out pin 10. C101 charges up immediately, and the analog voltage is amplified by IC 102 and the transistorized section Q101 thru Q111, causing the yoke to deflect the cathode beam to where we want the line to begin - the Initial Position.

STEP 2. Another 12 bit word is fed into the DAC-80. This word determines where the end of the line we are drawing will be. The DAC-80 again converts the digital word into an analog voltage that goes out pin 15 and into the analog switch IC1. Now the CPU sends out a Line Drawing pulse, closing the appropriate "switch" to let the analog voltage out pin 15 of IC1. The combination of R103, R102, and C101 has a time constant that determines how quickly C101 can charge (or discharge) to the new analog voltage on pin 15 of IC1. By adjusting R102, we change the amount of time it takes for C101 to arrive at the new analog voltage on pin 15 of IC1. Thus R102 determines the line length in the vertical (Y) direction. If the second (Line Drawing) analog voltage (IC1 pin 15) is greater than the first (Initial Position), the line will be drawn downward. If the second voltage is smaller, the line will be drawn upward.

In the horizontal channel, if the second analog voltage is greater than the first, the line will be drawn to the left.

Op-amp IC102 serves a dual purpose: It acts as a buffer between the deflection amplifiers and the analog switch, as well as an "edge gain" amplifier.

At the output of IC102, there is a resistor diode network consisting of R105 to R110, and D101 to D104. This resistor diode network is used to compensate for the non-linear characteristics of the CRT near the edges of the screen. If this circuit were not used, any object displayed on the screen would increase in size as it moved closer to the edges of the screen. Potentionmeter R109 adjusts the height of the pictures.

From the wiper of R109, the signal proceedes to Q101, which is the first stage of deflection amplification. Q101 to Q111 form a typical modern direct-coupled power amplifier with differential pair input and full complementary output. The differential pair consists of Q101 and Q103. The base of Q103 is tied to the amplifier output through the yoke and R117, forming a negative feedback loop. Q101 and Q103 (differential pair) compare input signal and amplifier output, and correct for any differences caused by amplifier distortion and the reactance of the yoke. Q102 is the constant current source for the differential pair (Q101, Q103). Bias for Q102 must be kept steady so Q102 collector current is constant. D105, D106 and R113 accomplish biasing. Note D105, D106 are in parallel with the base - emitter junction of Q102 and R113. The voltage across Q102 B-E junction plus voltage across R113 will equal total voltage across D105, D106, and the two forward biased diodes determine this voltage at 1.2 volts. Since the voltage across the B-E junction of Q102 is 0.6 volts, that leaves 0.6 volts across R113. The voltage across R113 is held constant, so the current through it is constant ($I = E \div R$) at 3 ma. Thus Q102 collector current is held constant near 3 ma.

The output of the differential pair (Q101, Q103) is fed into the base of Q104. Q104 is a class A amplifier whose output feeds Q208 and Q209.

Q105 is another constant current source. D109, D110, D111 determine the bias current in Q108, Q109, Q110, Q111.

So the deflection signal has traveled to the base of Q108 and Q109, the driver transistors. If the signal happens to swing positive Q108 will turn on, turning on Q110 which drives current thru the yoke and deflects the electron beam down. If the signal swings negative, Q108 and Q110 turn off, Q109 and Q111 turn on, and the beam deflects upward.

If the signal amplitude is excessive Q110 or Q111 (also known as the output transistors) will conduct heavily. The excessive current will cause voltage to develop across R120 or R121, and Q106 or Q107 will turn on. When this happens, the signal is removed from the base of Q108, Q109. Q108 and Q110 or Q109 and Q111 are turned off by this action and are protected from burning up. So Q106 and Q107 are protection transistors, and during normal operation they are inactive.

Note that Q108, Q110 control deflection in the lower half of the CRT screen, while Q109, Q111 take care of the top half. In the horizontal (X) channel Q208, Q210 control the left half; Q209, Q211 control the right.

Because the amplifier is a direct coupled loop, it defies ordinary signal tracing as a means of troubleshooting. If the signal is wrong anywhere in the amplifier, it will be wrong throughout.

R122, R123, and C102 form a RC network, which compensates for any counter EMF that may develop by the expanding and collapsing of the deflection coil's electromagnetic field.

The video high voltage module operates off the +25v supply and generates three different voltages for three circuits. It generates 16KV for the CRT ultor voltage. It generates +400vdc for the CRT focus voltage. And it generates +90 volts for blanking the cathode. The +90v is well filtered and fed into the brightness circuit on one end of R111.

The brightness circuit controls the amount of current going from the CRT cathode to the phosphor screen. It does this by varying the voltage on the CRT cathode. It also incorporates protection circuitry to protect the phosphors from burns. The main components in the brightness circuit are IC7, Q1, Q2, Q3, Q6, Q7, Q8, and R111, the brightness control. There are only two levels of brightness used in this system, which I will refer to as Normal and HI. The brightness information comes from the 74LS32 in position J2 on the logic board, through the ribbon connector, and into IC7. Normal intensity data enters IC7-1, and HI intensity data enters IC7-3.

Normal intensity data then goes out IC7-2 and turns Q1 on-off. Q1 acts as an on-off switch connecting and disconnecting R7 to ground (thru Q2). Thus, when Q1 turns on, the CRT cathode voltage is lowered (assuming R111 is at a normal setting) and the beam is turned on. When Q1 turns off, CRT cathode voltage returns to +90 volts, and the beam is cut - off (no brightness on screen).

Hi intensity data goes out IC7-4 and turns Q3 on-off. Q3 collector is connected to R8 (10K) in parallel with R9 (2.2K), R10 (5.6K). When Q3 turns on there is a lower resistance path between CRT cathode and ground than there was when Q1 turned on. Thus CRT cathode voltage drops to a lower voltage, and more current flows to the phosphor screen, creating a higher brightness.

Note that when either Q1 or Q3 conducts, the only path to ground is through Q2. If Q2 is off, the CRT cathode voltage cannot change, and no picture can appear. This means Q2 is a master ON-OFF switch for the cathode beam, and is the means through which our protection circuits can turn the beam OFF.

The first protection circuit consists simply of an unfiltered full-wave rectified +25 volts from the power supply. This voltage is slightly filtered by C10 and fed through R6 to Q2, turning it on. When the game is unplugged, the +25 unfiltered dies immediately and the beam is cut off, preventing a bright spot on the screen.

The second protection circuit consists of Q6, Q7, and two sections of IC7. Part of this circuit turns off the beam if the -25 volts from the power supply is lost (breaker trips, or?). In the absence of -25 volts, IC7-9 goes high (pulled up via R20), and IC7-8 goes low, pulling the base of Q2 to ground and Q2 turns off.

The other part of the circuit protects against having the beam on too long (in case of CPU failure, etc.). The high going pulses coming out of IC7-2,4 that turn on Q1, Q3 also turn on Q6 via R22, R23. Q6 amplifies and inverts these pulses to high-going low. Pulses then go through another inverter, so at IC7-10 they are low going high (active high). The active highs here correspond to the times when the beam is on, and charge up C24. If the beam is on too long, C24 will charge up enough to turn on Q7, making Q7 collector and Q2 base go low and Q2 turns off. In normal operation C24 can discharge through IC7-10 when IC7-10 goes low.

Now, a paragraph about Q8. Q8 is the path through which IC7-2,4 receives its operating +5 volts. R19 and C23 form a time delay, so when power is first turned on it takes a while before Q8 turns on and +5 volts gets to IC7-2,4. Thus, all other circuits get a chance to stabilize before the beam is turned on.

R111 is the brightness potentiometer, which adjusts the amplitude of the negative pulses used for Normal and HI brightness.

B. CPU BOARD

The processor hardware can be broken down into five basic functional blocks as shown in Figure 6-1. The arrows indicate the possible data flow directions between the various blocks. The ALU and Control block are the main components of the processor while the Memory and I/O blocks may be thought of as merely peripherals. Figure 6-2 is a detailed block diagram of the processor. The numbers in each block correspond to the entries in Table 6-1, which lists the IC numbers of the main components of each functional block.

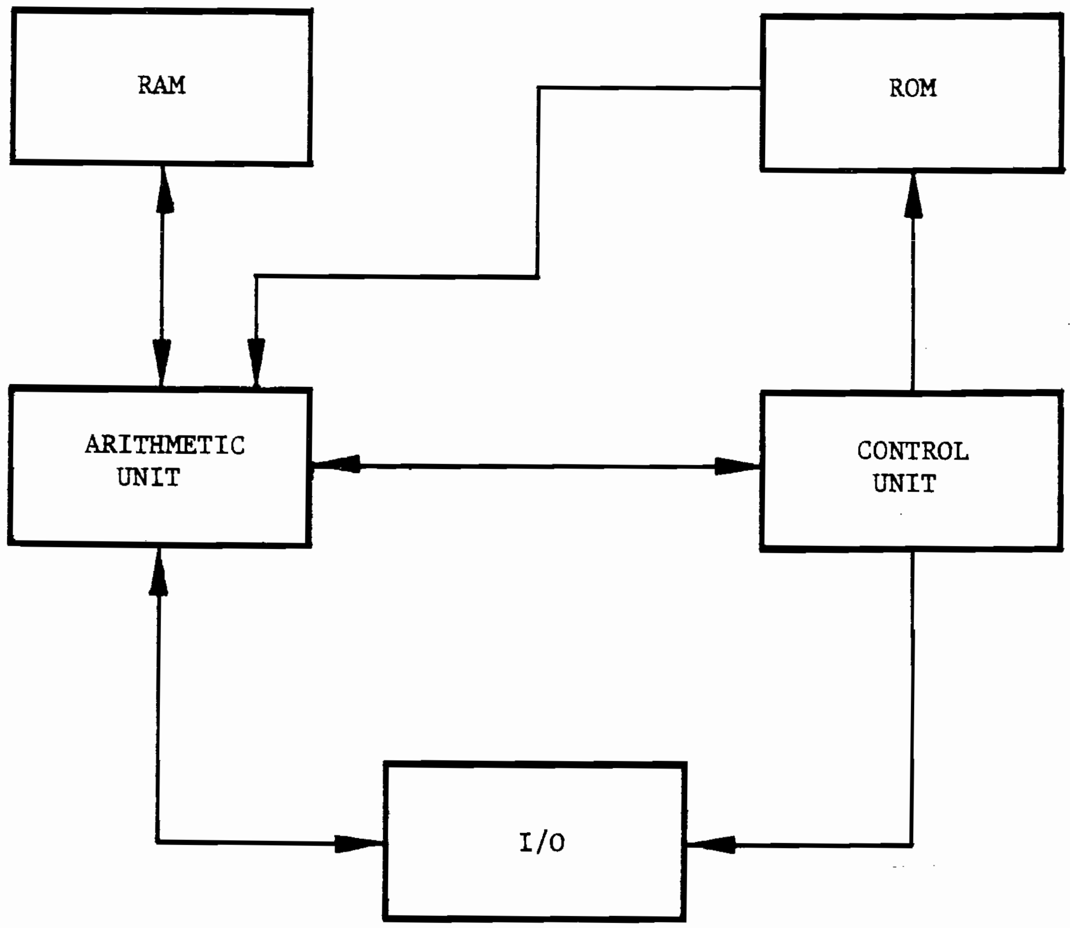


Figure 6-1. CPU Functional Block Diagram

The following is a brief description of each block shown in Figure 6-1. The numbers beside each functional block name are the numbers in Figure 6-2 which correspond to a particular function.

RAM (6)

The RAM is implemented with three read/write static memories configured as a 256 x 12 bit block. Data can be transferred to or from this memory via the ALU block. The processor uses this RAM as a scratch pad.

ROM (10)

The ROM is configured as an 16K x 8 bit block of memory. These memory locations contain the program instructions and/or data. It is accessed via the processor control unit.

I/O 19, 17, 18

The I/O block consists of 8 output lines implemented with a bit addressable latch, 24 input lines implemented with data selectors, and two 12 bit registers which are connected to the X Y display deflection circuits via D/A convertors.

Arithmetic Unit 1,2,3,4,5

The arithmetic unit performs all the arithmetic processing for the system. It consists primarily of two 12 bit accumulators, an arithmetic logic unit and various data selectors. The accumulators can function as temporary storage registers for arithmetic functions upon the data in the accumulators. The data selectors are used to select the various sources of data which will be processed.

Control Unit (15,16,14,7,8,9,11,12,13)

The control unit is the heart of the processor. It performs all instruction decoding operations and generates all the necessary control signals which the rest of the hardware requires to function correctly.

The following is a discussion of each block shown in Figure 6-2.

1. Accumulator Selector

The accumulator selector consists of 3 quad data selectors. They are used to select the output of either the primary or secondary accumulator for processing by various other sections of the systems.

2 & 3 Primary and Secondary Accumulators

The two 12 bit accumulators are implemented with quad bidirectional shift registers. The primary accumulator consists of S4, P4, M4. The secondary accumulator consists of T4, R4, N4. All data manipulation in the processor is accomplished using these two accumulators. All output data flows through these registers.

4. Arithmetic Logic Unit (ALU)

The ALU is used to perform all necessary arithmetic functions within the processor. The ALU is implemented using three 24LS181 (N6M6L6) function generators, three 74LS85 (N9,M9,L9) 4 bit magnitude comparators, and a 74S182 (L4) look ahead carry generator. The data which the ALU manipulates can come from four different sources. The first source is the contents of the accumulators via the accumulator selector. The second and third sources are the ROM and RAM data outputs via the ALU data selector (N11, M11, L11) and the fourth source is the external input selector (E4, D4, C4).

5. Data Selector

The data selector is used to read data into the ALU from either the RAM or ROM memory. Note that the ROM data is only 8 bits wide while the RAM data is 12 bits wide.

6. RAM Storage

The system RAM consists of three 9101C high speed static memory chips connected as a 256 x 12 bit block. The block is 12 bits wide in order to allow the contents of an accumulator to be stored. The processor uses the RAM as temporary storage of program variables, data pointers or any other data of a dynamic nature.

7. RAM Address Selector/Register

The output of this register is tied directly to the address lines of the RAM. It consists of a multiplexer which routes address data from either the ROM or RAM locations to the RAM address lines. The capability to use RAM data to select RAM addresses is the basis for the indirect addressing mode of the processor.

8. Page Selector

The page selector is used to latch the high order 4 bits of a RAM access instructions.

9. ROM Data Register

The register is used to temporarily hold data from the ROM during an instruction fetch.

10. ROM Memory

The ROM memory consists of the actual memory chips plus a data selector and latch circuit. The latch is used to improve the memory access time during a two byte instruction fetch by allowing one byte of the instruction to be latched while the RAM address lines are decoded for the other byte. The data selector can then be used to rapidly access both bytes of the instruction by switching between the latch and memory outputs.

11. Instruction Register

The instruction register is a latch which holds the current op code as read from ROM. Its output is tied to the instruction decode circuitry which in turn generates the necessary signals to execute the instruction.

12. System Sequencer

The system sequencer is used to decode an instruction op code and to generate the appropriate timed sequence of signals which execute the instruction. The op code is decoded by using it as the address data to a set of decoder ROMS. The outputs of the decoder ROMS are then synchronized with the system clock and used to control the various system functional blocks.

13. Line Length Counter

The line length counter is used during the process of drawing a vector to control the length of a vector, by turning off the beam at a pre-determined time after the vector is intiated. The counter is loaded with a value from a line length ROM and then counts up until it overflows which in turn generates a signal to indicate the vector has been finished.

14. Program Address Selector

This selector is used to provide the address data to the program ROM. It selects either the program address counter output or the accumulator selector output and routes this data to the ROM address lines. The ability to use the accumulator contents as address data allows the program to randomly access data tables stored in the ROM or to compute a branch address after a conditional test.

15. Program Address Counter

This is a 12 bit counter whose output defines the next location in ROM to be accessed. It is normally clocked sequentially to step through a program. However, it can be loaded with data from the program address register which is how the jump instructions are implemented.

16. Program Address-Register

This register is a latch used for temporary storage of an address which will be loaded into the program counter during a jump instruction. The input data to this latch can come from either the program ROM or the scratch-pad RAM.

17. Input Selector

The input selector is used to read the state of one of the 24 input lines into the selected accumulator. There are 16 primary inputs and 8 secondary inputs. During an input instruction the upper 11 bits of the accumulator are set to zero while the least significant bit reflects the state of the input line. All input lines have pull up resistors on them so that they will read high if they are left unconnected.

18. Output Selector

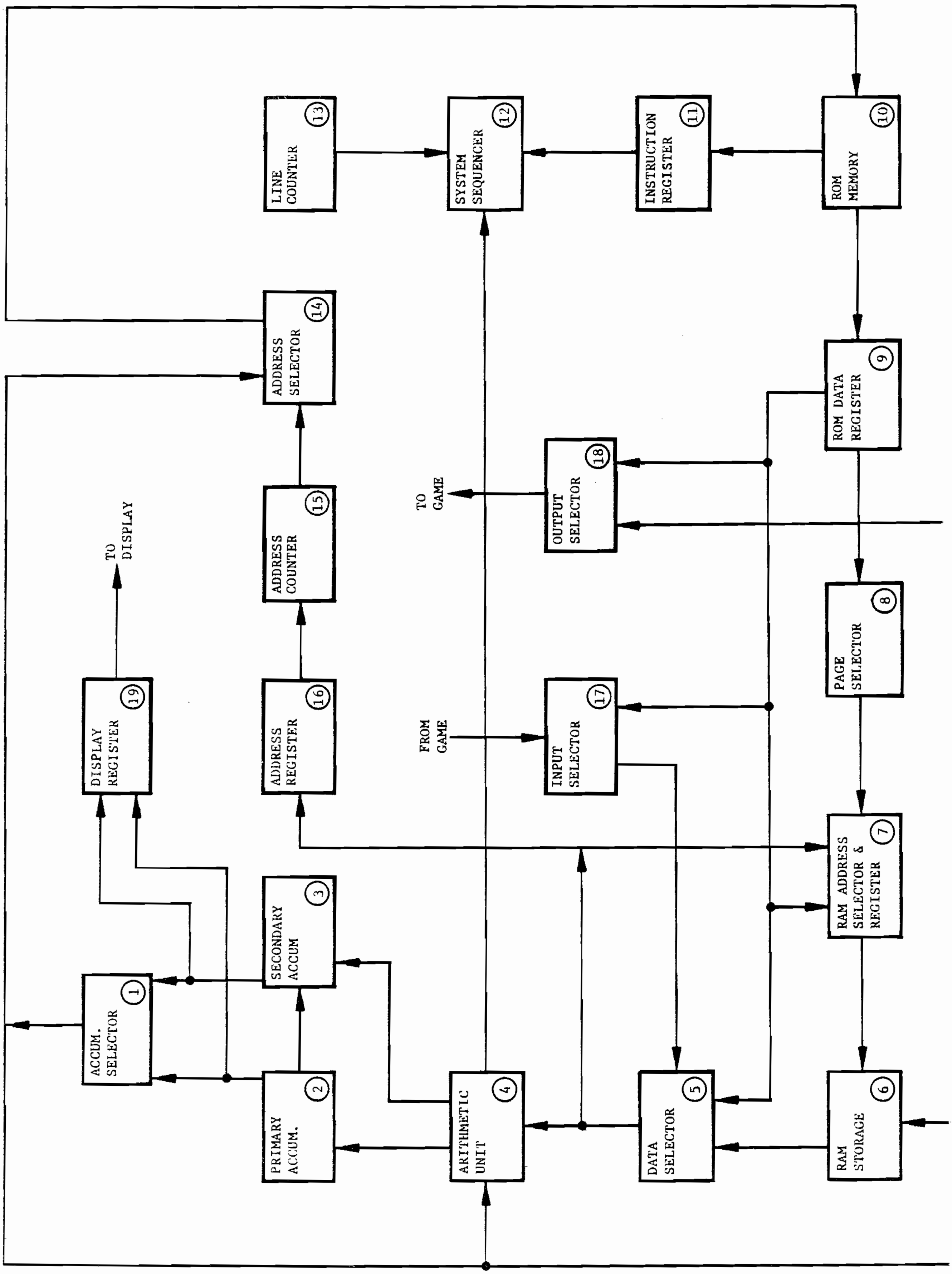
The output selector is a bit addressable latch used to control the 8 output lines. During an output instruction the selected output line is set to the complement of the least significant bit of the accumulator. The output lines are used to control the audio board, display intensity and the mechanical coin counter.

19. Display Registers

The display registers are the interface between the processor and the display driver circuits. These registers are latches into which the contents of the accumulators can be stored. The outputs are tied to D/A converters which provide the input voltage to the display deflection amplifiers.

TABLE 6-1. BLOCK NUMBERS AND COMPONENT I.C.

1. T-2, R-2, N-2
2. S-4, P-4, M-4
3. T-4, R-4, N-4
4. N-6, M-6, L-6, N-9, M-9, L-9
5. N-11, M-11, L-11
6. N-14, M-14, L-14
7. J-12, I-12
8. H-12
9. S-13
10. U-7, R-7, T-7, P-7, U-9, T-9, U-11, T-11
11. T-13
12. A-8, G-10, F-10, G-14, F-14, E-14, D-14, C-14
13. E-6, D-6, E-8, H-8, G-8, F-8
14. S-9, R-9, P-9
15. S-11, R-11, P-11
16. P-13, R-13
17. E-4, D-4, C-4
18. F-2
19. S-2, R-2, M-2


ACCUM. SELECTOR 1
PRIMARY ACCUM. 2
SECONDARY ACCUM 3
ARITHMETIC UNIT 4
DATA SELECTOR 5
RAM STORAGE 6
RAM ADDRESS SELECTOR & REGISTER 7
PAGE SELECTOR 8
ROM DATA REGISTER 9
ROM MEMORY 10
INSTRUCTION REGISTER 11
SYSTEM SEQUENCER 12
LINE COUNTER 13
ADDRESS SELECTOR 14
ADDRESS COUNTER 15
ADDRESS REGISTER 16
INPUT SELECTOR 17
OUTPUT SELECTOR 18
DISPLAY REGISTER 19
TO DISPLAY
TO GAME
FROM GAME

C. AUDIO BOARD

CIRCUIT DESCRIPTION AND TROUBLESHOOTING GUIDE

GENERAL INFORMATION

The following section describes the theory of operation for the Armor Attack audio board. The appendix contains block diagrams of the audio board. The theory of operation of each block will be described along with test techniques to enable effective troubleshooting.

An asterik (*) to the left of a title of a section indicates a detailed discussion that will be used elsewhere in the section.

DEFINITIONS

TTL (Transistor - Transistor Logic) compatible levels are defined as follows:

1) A TTL "low" or logic O is any voltage less than 0.8 volts.

2) A TTL "high" or logic 1 is any voltage greater than +2.0 volts.

3) A voltage within the range of 0.8 to 2 volts on any logic point indicates a bad part or an open input.

VCO: Voltage Controlled Oscillator

CCA: Current Controlled Amplifier

IC: Integrated Circuit (chip)

NOTATION

A particular pin of an IC (Integrated Circuit) is denoted in the text by first the chip designation and then the pin number—e.g. IC25-10 means pin 10 of IC 25.

Jumper patches W1 thru W13 are sections of traces on the audio board designed to be cut in order to isolate a section of circuitry for test purposes. Be sure to cut between the two eyelets, one round and the other square. The orientation of these pads is the same on the board as on the schematic diagram. Repair by adding a short jumper wire into the holes provided.

DO NOT repair any traces by adding a blob of solder at the cut. This will cause intermittent operation.

CAUTIONS

NEVER connect pin 5 of a CA3080 (CCA) directly to ground or any voltage other than -15 volts. Failure to observe this rule can cause the IC to explode (also known as the plastic pop-corn effect).

NEVER connect a TTl output to +5 volts. The plastic pop-corn effect applies here also.

TEST EQUIPMENT

For troubleshooting this board you will need:

1) V.O.M.

2) logic probe - not necessary, but recommended

3) several jumper wires with "E-Z"

4) an oscilloscope - not necessary, but recommended

TROUBLESHOOTING

All VCO outputs will measure 13 to 15 volts AC with a VOM (volt-ohm meter).

All 555 multivibrator outputs will measure 1.5 to 3 volts AC with a VOM.

INPUT CONTROL CIRCUITRY

(refer to block diagram 1)

IC1 and IC27 are schmitt-trigger inverters that clean up digital information arriving at connector J2 on pins 11, 15, & 16. The CPU board controls all sound generation by supplying digital data pulses through 16 pin connector J2. IC2 and IC3 latch this control information on the board as follows—

IC2 (74LS164) is an 8-bit serial to parallel shift register. Data in the form of a bit stream moves from connector J2-16 through IC1 and into pin 1 of IC2. Pin 8 receives clock pulses from the CPU via J2-15. Each pulse causes a single bit of data present at pin 1 to be transfered successively down the line to outputs A thru H. When the eight output ports are filled, IC3 (74LS377) swings into action. The outputs of IC2 are tied to the inputs of IC3 (1D-8D). When IC3 receives a load pulse on pin 11 thru connector J2-11, the data present on each of its inputs is transferred straight across to its outputs ports (1Q-8Q). Now data which entered on one channel thru connector J2-16 is available for use in the 8 channels of latch IC3.

TEST PROCEDURE

To verify proper operation of IC1, disconnect 16 the pin ribbon cable connector, J2 and decrease volume. Check IC1-2 with a logic probe, scope, or meter. It should read high or 2.4-5vDC (logic 1). Repeat for IC-11 and IC27-6.

With a test lead, ground IC1-13. The output, 1C1-2 should now read low or (0-6.7) vdc, logic 0. Repeat for the other two pairs of schmitt-trigger circuits.

To verify proper operation of IC2, load all lows into its output ports by tying IC-13 to ground. With another test lead connected to ground tap IC2-8 about 10 times. Output A thru H should now all read low. At this point, tap IC3-11 with the ground lead. Outputs 1Q-8Q should now all read low.

Repeat the above procedure, but remove the ground lead from IC1-13. This should load all highs into all the output ports. This completes all the tests.

At this point the volume control may be turned up. No sound should be heard.

QUICK CHECK PROCEDURE

At this point all of the sounds generated on the audio board can be tested one at a time. Follow the above procedure for loading all 'ones' into the input control latch (IC3).

TABLE 1.

Table of Test Points for the quick check procedure.

TABLE 1

Sound	Test Point	Ground/ Open	Tap/ Hold
Chopper	J2-14	G	T
Beep	J2-13	G	T
Tank	J2-12	G	H
also	IC3-19	G	H
Tank Fire	IC3-2	G	T
Hi Explosion	IC3-5	G	T
Jeep Firing	IC3-6	G	T
Lo Explosion	IC3-9	G	T

Using a test lead ground the test points shown in table 1 to activate the desired sound. Some sounds on the test point e.g. explosions. To fully exercise the tank sound refer to it's troubleshooting procedure.

NOISE GENERATOR

(refer to block diagram 2)

The noise generator circuitry is composed of IC17, a digital noise generator, a DC blocking network C21 and R26, and a voltage follower, IC18. Both outputs have a minimum amplitude of 11.5V P-P, with the waveform at IC18-6 centered about ground.

TEST PROCEDURE

Check for proper amplitude signal at outputs (IC17-3 & IC18-6). IC18-6 will read approximately 2.5V RMS or 11.5 Vp-p.

* TANK FIRE SOUND

(refer to block diagram 2)

This sound is activated whenever the tanks shoot. The basic components of this circuit are white noise, from the noise generator, a low pass filter, a current controlled amplifier (CCA), an envelope control circuit, and a voltage switch.

LOW PASS FILTER

The output of the noise generator circuit is fed into the low pass filter, R34-38, C23-24. The filter output is then fed into the CCA IC19-2 and 3.

CURRENT CONTROLLED AMPLIFIER (CCA)

IC19 can be imagined as an amplifier that generates a current waveform characteristic of the voltage appearing at pin 2. The strength orgain of the output current (IC19-6) is proportional to the current injected into pin 5 via R33 (refer to Fig. 1, pg. 6-16).

ENVELOPE CONTROL

R33 controls the amount of current injected into pin 5 of the amp and the RC time constant of R33 and C22 determines the envelope or decay time of the output waveform.

VOLTAGE SWITCH

The circuit is turned on by switching a low level on the base of Q2. This pulls the voltage up to the emitter of Q3 from -3.5v to +1.9v forward biasing Q3 and allowing it to inject current into the CCA.

TEST PROCEDURE

With J4 disconnected from the CPU board load all 'ones' into the output latch (IC3), (refer to input control circuitry), the junction of R27 and R28 will read about 5vdc. Grounding this point should cause the collector of Q2 to swing from -3.5v to almost 4.7v, the emitter of Q2 should remain at a constant 5vdc. The upward voltage swing on the collector of Q2 should turn on Q3 and cause it's colllector to rise from about -14.3 to about 5vdc. If, for any reason the voltage switch circuit is suspect, it may be eliminated by cutting W1 and tapping a grounded test lead to the square pad of W1. In either case a roar should be heard in the speaker. If this is not the case, verify that the noise generator is functional and that the tank firing circuit is receiving noise at R34. If any of the following sounds work, (see quick check procedure) lo explosion, chopper, jeep firing, or hi explosion, replace IC19. If none of the above operate, perform a check of the voltage follower circuit (see voltage follower). If the voltage follower is operating correctly, one of the other CA3080's may be shorted. To isolate a. y of the CA3080's whose outputs feed the voltage follower, you may cut their output pin, pin 6, and use a test lead to connect the output of the CA3080 to the input of the voltage follower circuit, IC25-3. Don't forget to exercise the appropriate sound.

Using the above procedure the offending CA3080(s) can be located easily.

VOLTAGE FOLLOWER

(refer to block diagram 1)

R90 converts the total current output of all the CA3080's to a voltage. Since this is a high impedance point IC25 is used to "beef up" the signal on the top of R90, before feeding it to the pot driver (IC26).

TEST PROCEDURE

If any of the following, lo explosion, chopper, jeep firing, or hi explosion sounds, work it's pretty much a safe bet that IC25 is ok. However if none of the above sounds work the test procedure is as follows: cut IC25-3 and apply a known good signal to IC25-3, on the chip itself not the board. NOISE from IC18-6 is a good choice. Observe the output (IC25-6). If the input control latch is set-up properly, so that no sounds are on, the NOISE signal will be heard in the speaker.

LO EXPLOSION

(refer to block diagram 2)

The lo explosion is heard whenever a missile strikes a wall. The technical description is identical to that of the tank firing sound. The differences between the two circuits are different component values in the low pass filter and envelope control circuitry. These are for a different frequency response, amplitude, and decay time.

TEST PROCEDURE

See test procedure for tank firing sound.

CHOPPER SOUND

(refer to block diagram 3)

The chopper sound is heard whenever the chopper appears on the screen. For a technical description see the technical description on the tank firing circuit. The differences between the two circuits are different part values in the low pass filter and envelope control circuitry. It should be noted that there is no capacitor in the envelope control circuit. This gives the chopper sound a fast attack and decay. Also note that there is no oscillator on the audio board for this sound. The "blade rate" is controlled entirely by the CPU board.

TEST PROCEDURE

See test procedure for tank firing sound. The only difference here is that the chopper sound is enabled by grounding IC27-3, it is not driven off the latch, IC3.

JEEP FIRING AND HI EXPLOSION SOUNDS

(refer to block diagram 3)

The jeep firing sound occurs whenever the jeep shoots. The high explosion sound occurs when a tank is struck for the second time. It also occurs when either a jeep or the helicopter is hit.

The technical description of these sounds is identical to that of tank firing sound with one major difference. These two sounds share a common low pass filter and a CCA (IC22).

TEST PROCEDURE

See the test procedure for the tank firing circuit. The only additional trouble shooting step required here would be to cut both W4 and W5 when attempting to enable IC22. Grounding the square end of W5 should yeild a louder noise in the speaker than when grounding the square end of W4.

BEEP SOUND

(refer to block diagram 3)

The beeper generates the morse code sound, which occurs at the beginning and end of the game. It also occurs whenever a new jeep arrives on the screen.

The morse code sound is generated by a gated oscillator consisting of IC23, R81-83, C35 and C37. The CPU enables this oscillator, a 435 cycle note, J2-13. The output of the oscillator, a 435 cycle note, is coupled to the summing junction via R83 and C36.

TEST PROCEDURE

With the cable removed from J2 both the reset input IC23-4 and the output IC23-3 of the gated oscillator should be low. Ground J2-13. The reset input of the gated oscillator should go high and a 435 KHz rectangular waveform should appear at IC23-3.

TANK SOUND

(refer to block diagrams 4 and 5)

The tank sound is a composition of two sounds, the tank motor sound and the tread squeak sound.

The tank motor sound is generated by a gated oscillator, several digital division circuits, a mixer and a shaping network.

The generation of the tank sound originates at the gated oscillator consisting of IC6, R2-3, C11 and C12. The CPU enables this oscillator with a low level on J2-12. The output of the oscillator, a pulse train with a period of 136 micro-seconds is fed to a programmable divide by N circuit, after squaring by IC1.

* PROGRAMMABLE DIVIDE BY N CIRCUIT

The programmable divide by N circuit consists of IC8 and ¼ of IC9, a nand gate. When IC8-9 is pulses low the four bit number on the D, C, B and A inputs is transferred to the outputs Q(d) thru Q(a), respectively. Since this is an "UP" counter every time the clock input is struck with a positive transition the outputs of the counter will increment until a count of 15 is reached, all outputs high. At this time the carry output IC8-15 will go high causing the load input IC8-9 to go low. The load input will be recognized on the next positive transition of the clock, thereby causing the cycle to repeat.

Note that this circuit will not function if all inputs to the counter, TS0+ thru TS3+, are all high. Refer to table 2 for a listing of input codes versus division rates.

TABLE 2

Table of frequency selection inputs v.s. output frequency and period for the programmable divide by N circuit.

Frequency input = 7.35 KHz, a period of 136 micro-seconds

All pins noted are IC8.

----------inputs----------				----------outputs----------		
6	5	4	3		15	
TS3+	TS2+	TS1+	TS0+	FREQUENCY	PERIOD micro-seconds	DIVISION RATE
1	1	1	1		–ILLEGAL–	
0	1	1	1	833Hz	1200	9
1	0	1	1	1.47KHz	680	5
1	1	0	1	2.5KHz	400	3
1	1	1	0	3.7KHz	270	2

The operation of the divide by 13 circuit consisting of IC11 and 1/6 of IC1 is identical to that of the divide by N circuit, the only difference being the fixed division rate. Note also that the output of this circuit is taken from the Q(d) and not the carry output.

IC10 is utilized as a divide by 16 circuit. Note that, whereas the outputs of both IC8 and IC11 change on the positive transition of the clock, this output IC10-6 alternates only on the negative edges of it's clock, IC8-1.

The outputs of both the divide by 16 and the divide by 13 circuits are mixed at IC9-9, 10. The mixer output IC9-8 is fed to IC10-13 where it is divided by two. This last division by two insures that the waveform fed to the shaping network is always a squarewave.

The shaping network consisting of R6, R7, C13 and C14 preforms a bandpass function on the motor sound before it is sent to the summing junction of the preamp.

TANK TREAD SQUEAK

(refer to block diagram 5)

The tank tread squeak is generated by a gated binary counter, "wired nor" function, several low leakage switches, a summing and filter network, VCO, bipolar to TTL converter, a gated octive adder and a pair of inverters.

The gated binary counter, IC13, is enabled by the compliment of the TANK EN+ signal. It's clock input IC13-13 is fed by the output of the divide by 16 circuit, IC10-6, in the tank motor sound. Only the divide by 16, IC13-8, and divide by 8 outputs, IC13-9 are used.

Both outputs drive three Low Leakage Switches, (LLS). Two of these are driven directly. The last enabled via a "wired nor" function consisting of two open collector inverters IC7-5, 6, 10 and 11. The output of the "wired nor" function is low IC7-6 and 10, if either of its inputs IC7-5 or 11 is high.

LOW LEAKAGE SWITCH

The first Low Leakage Switch (LLS) is composed of Q14, Q15 and R95 thru R99. With IC13-8 high the base of Q14 rests near +5 volts. Due to lack of base of Q14 is cut-off, causing it's collector voltage to drop to -3.5 volts. Q15 now sees a severe reverse bias and responds with almost an ideal open circuit collector to emitter.

The first LLS is enabled by a low on the divide by 16 output of the gated binary counter, IC13-8. When IC13-8 goes low the base of Q14 drops to about 4.3 volts, turning it on, and causing the collector to rise to 4.7 volts. Q15 responds to this forward base drive by grounding it's collector.

The three Low Leakage Switches drive the VCO IC15-5 via a summing and filtering network composed of R19 thru R23 and C18. This network of passavie components converts the on and off states of the three Low Leakage Switches to a single time varying analog signal.

This analog signal at the top of C18 is injected into IC15-5, the control voltage pin of the VCO. As the control voltage ramps between +12vdc and +14vdc the squarewave

output of the VCO will ramp down in frequency from 27khz to 23khz. The output of the VCO (IC15-3) is then fed into the Peak-Peak to TTL converter. A 5v p-p squarewave enters the clock input of the Gated Octave Adder IC13. The outputs are then added together and sent on to the summing junction. The sound is enabled by bringing IC13-2 to a low level.

TEST PROCEDURE

To troubleshoot the tank sounds load all ones into the output latch IC3, refer to Input Control Circuitry.

The programmable divide by N circuit may be checked by grounding the inputs IC8-3 through 6 singularly. Refer to table 2 for correct frequency readings on the output IC8-15.

Ground IC27-13 and IC3-19. Using table 3 and an oscilloscope, verify the timing of all the digital division circuitry in the tank motor sound and the gated binary counter in the tread sweep circuit. Both the input, IC10-13 and the output, IC10-11 of the divide by two circuit posses considerable "jitter", activity is observed at these points they are probably ok.

Table 3

Table of frequency and period readings for the tank sounds.

TEST SETUP: IC8-4, 5 and 6 high, IC8-3 low, J2-12 low.

IC	PIN	PERIOD	FREQUENCY
6	3	136 micro-sec.	7.35KHz.
8	2	136 micro-sec.	7.35KHz.
8	15	270 micro-sec.	3.7KHz.
11	11	3.5 milli-sec.	285Hz.
11	15	3.5 milli-sec.	285Hz.
13	8	70 milli-sec.	14Hz.
13	9	35 milli-sec.	28Hz.
7	6	70 milli-sec.	14Hz.

The operation of the Low Leakage Switches may be verified as follows; ground IC27-13 and IC3-19. Remove all other grounds that may be attached. The bases of the pnp transistors, Q14 for example, should be swinging between 4.3 and 5 volts, small but ok. The collector of the same transistor should pulse from almost 5 volts down to -3.5 volts. If a 'scope is available check the output of the pnp transistor, it should go from a bit above ground to at least 8 volts. If a 'scope isn't handy and the pnp transistor is suspect, cut the troubleshooting jumper, W11 in this case, and temporarily install a resistor, 2K to 20K, between +15 volts and the round pad of the jumper. Short the pnp transistor base to collector. Using a VOM meter the collector of the pnp transistor. It should read +15 volts. Ground driver circuit, IC13-8 in this case. Anything above 0.3 volts at the collector indicates a bad npn transistor.

To check the VCO, peak to peak to TTL converter and gated octave adder, remove the ground from IC27-13. Ground IC13-2. Using table 4 and a 'scope, check the outputs of the VCO and the gated octave adder.

Table 4

Table of frequency and period readings for the tank squeak sound.

TEAT SETUP: IC27-13 high.

IC	PIN	PERIOD (micro-seconds)	FREQUENCY (KHz)
15	3	42	23.8
13	3	84	12
13	4	168	5.95
15	5	336	2.97

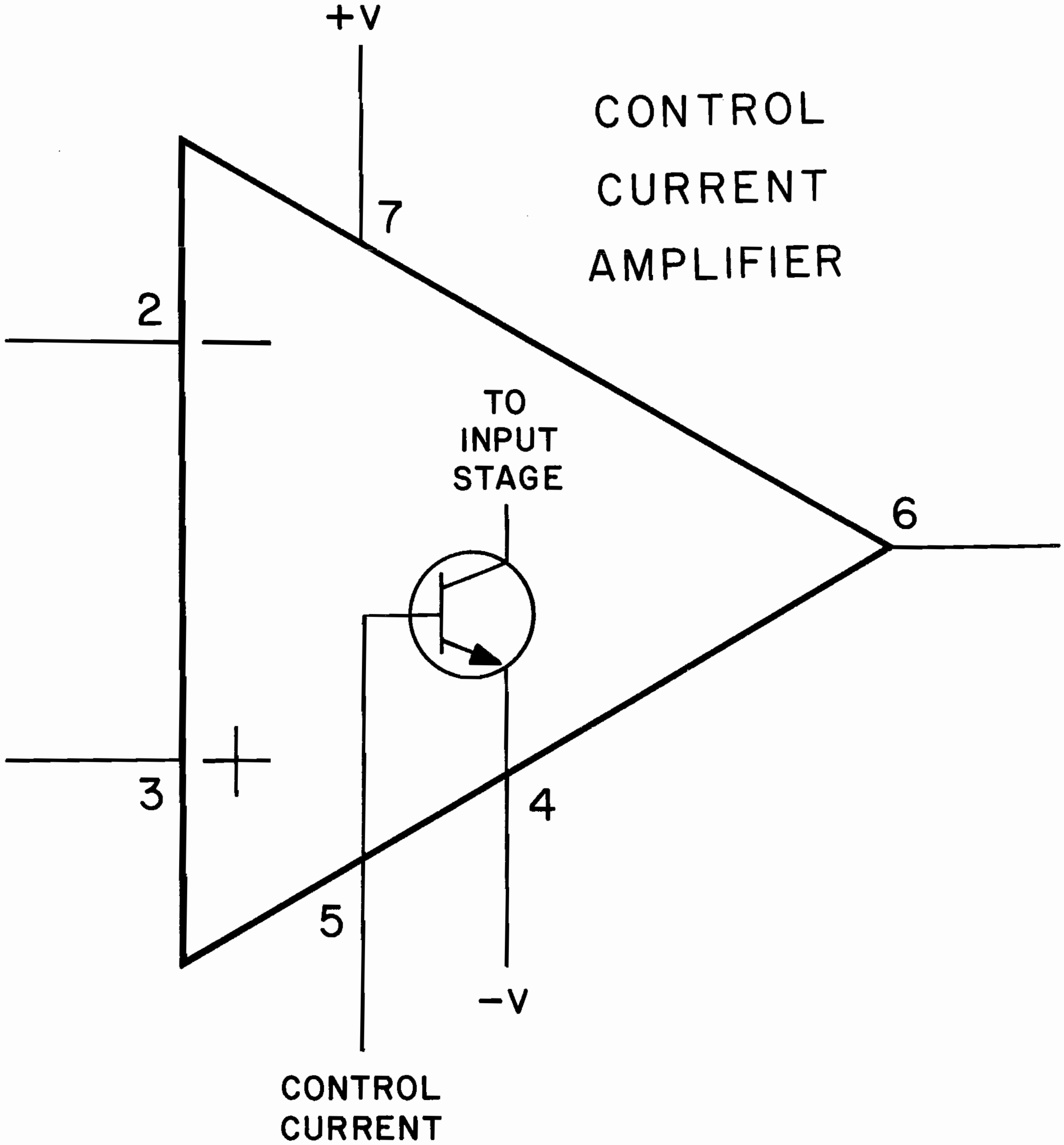
OUTPUT AMPLIFIER

(refer to block diagram 1)

The output amplifier section consists a pre-amp and volume pot driver IC26 (TL081), main driver amp IC24 (TL081) and speaker drive transistors Q12 and Q13.

IC26 drives the external volume pot located on the coin door and its associated cable. If little or no volume is heard, meter the pot wires between J1-8 and J1-3. The resistance should vary as the pot is rotated. If the audio is at maximum volume regardless of the pot position, suspect an open lead between ground and the pot lead connected to connector J1-1.

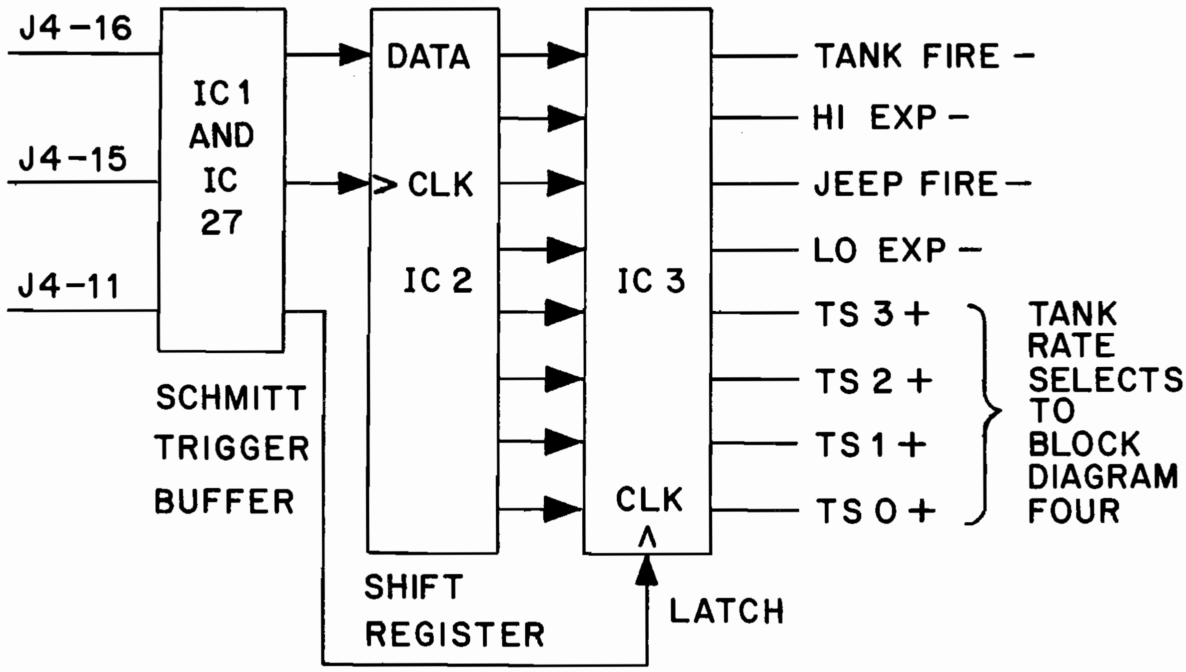
The final drive is a non-inverting amplifier circuit containing IC24, Q12 and Q13. Observe the waveform at the speaker wire which is the emitter junction of Q12 and Q13. If the upper half of any sound waveform appears clipped, suspect Q12. For the lower half, Q13 is the suspect. For no audio meter Q12 and Q13 out of circuit and look for burned resistors R122 and R124. Also check diodes D6 and D7 at this time.



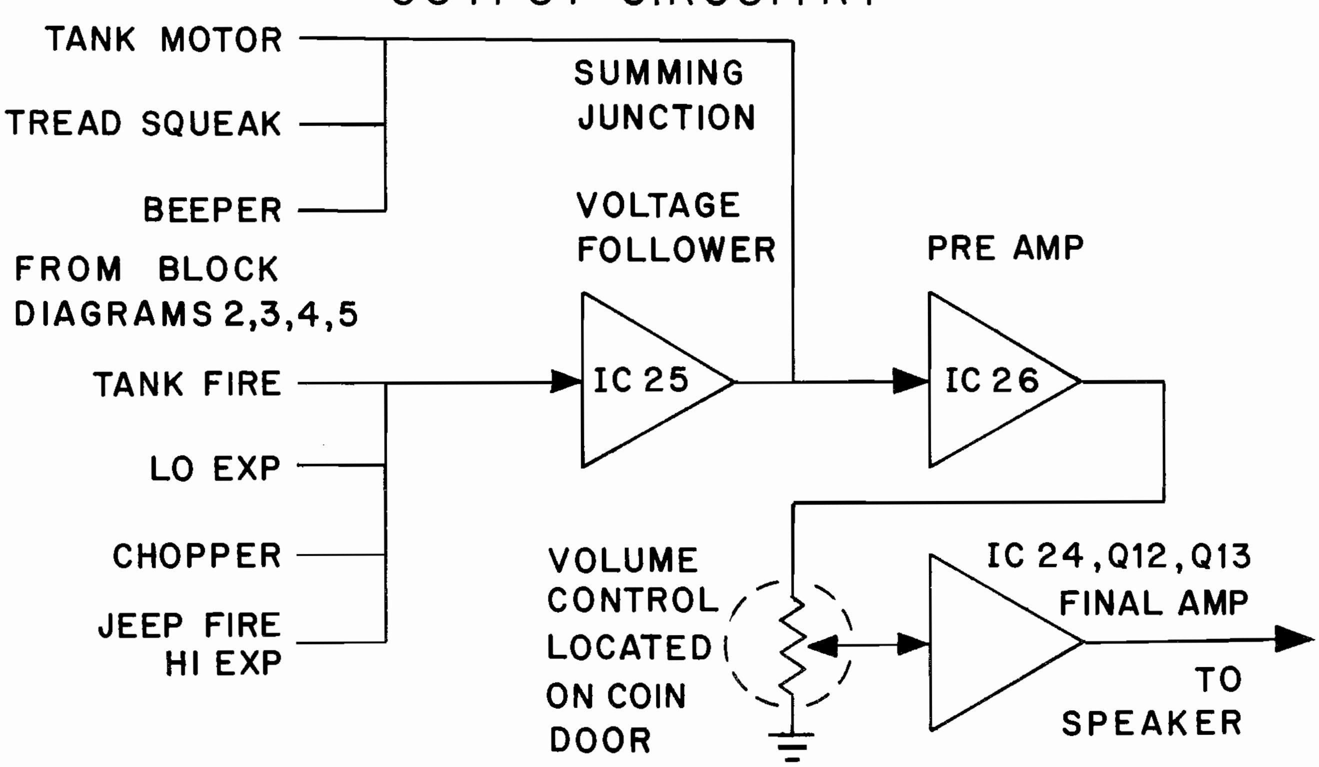
+V
CONTROL
CURRENT
AMPLIFIER
7
2
TO
INPUT
STAGE
6
3
4
5
−V
CONTROL
CURRENT

FIGURE ONE

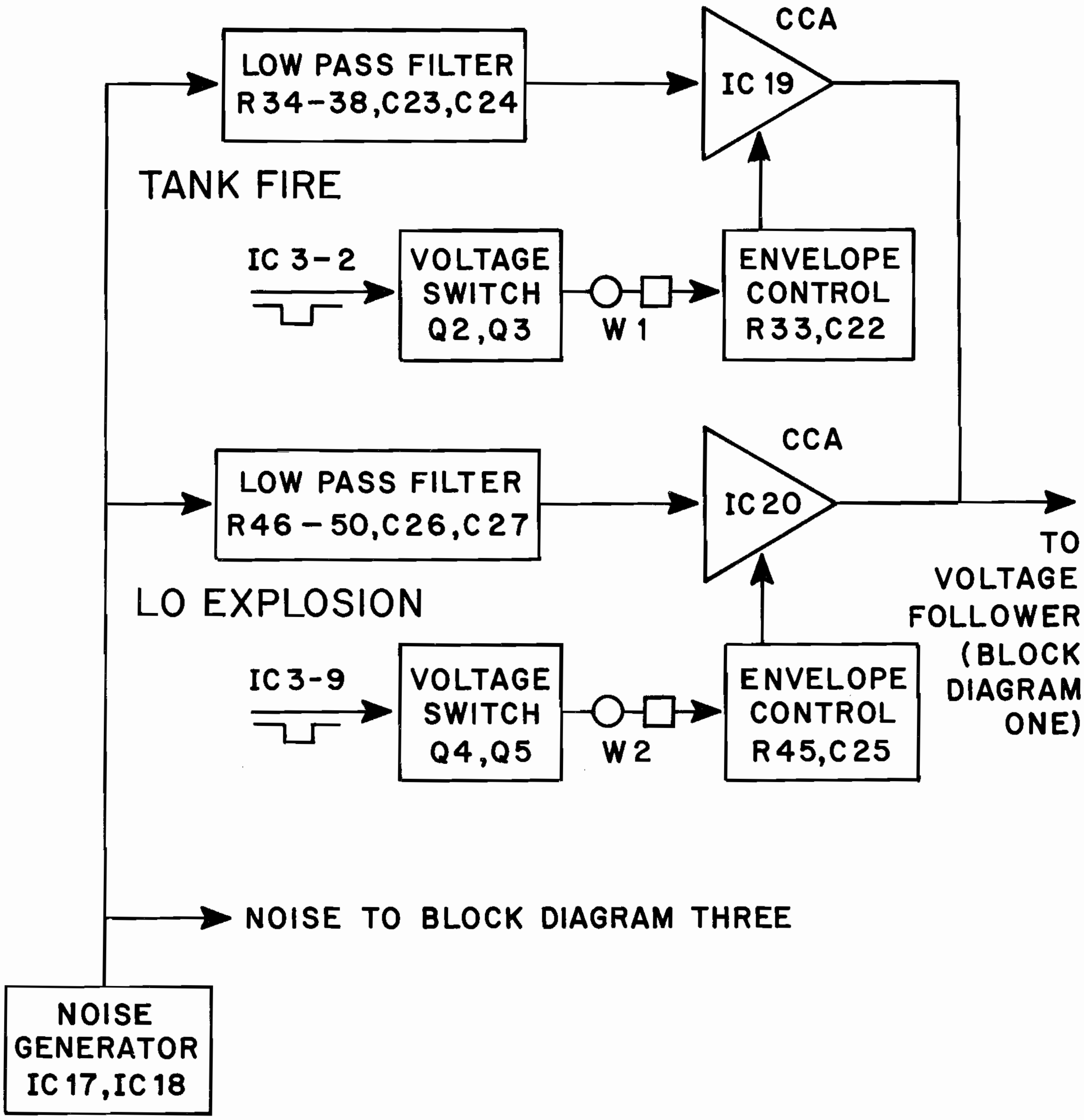
INPUT CONTROL CIRCUITRY



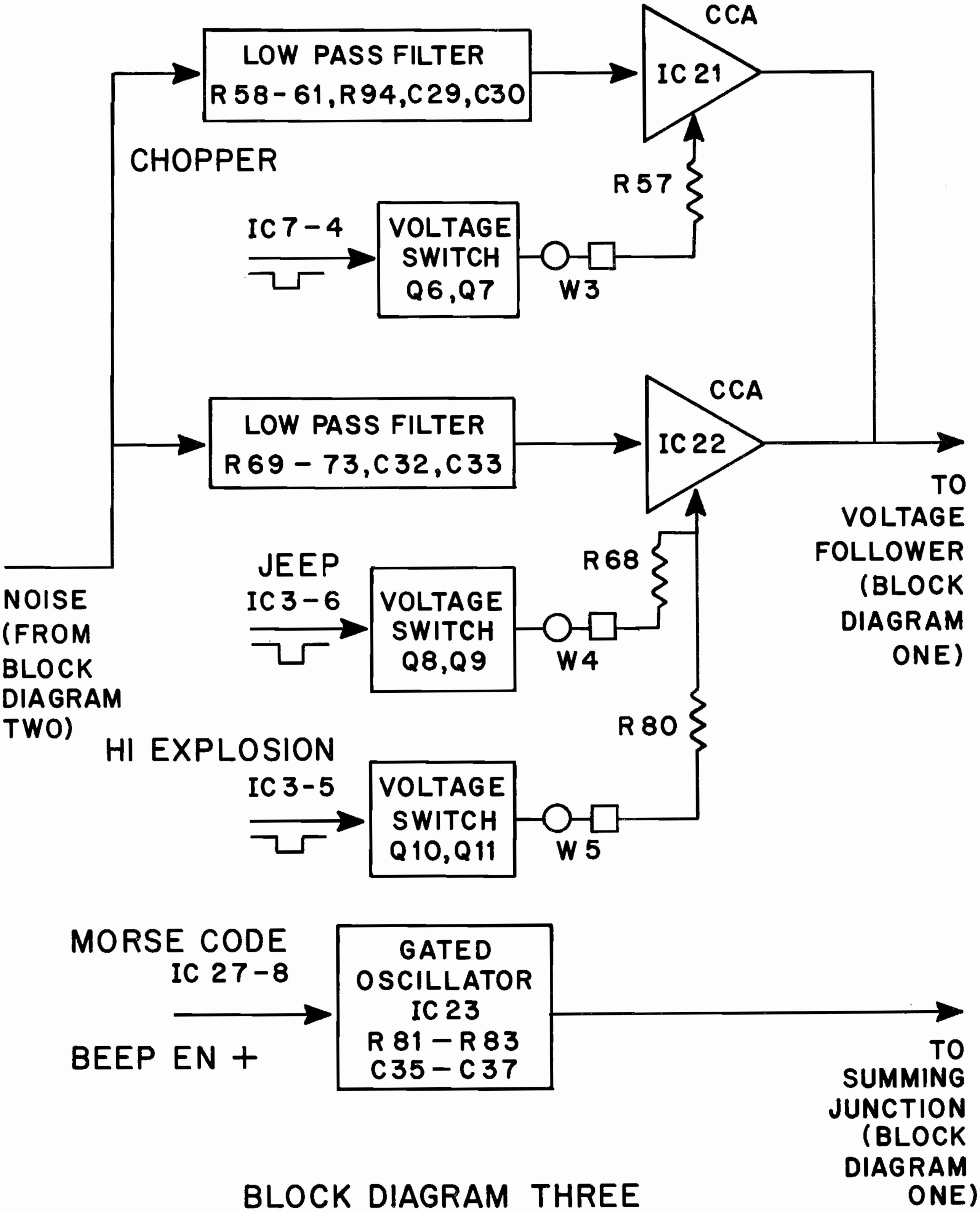
OUTPUT CIRCUITRY



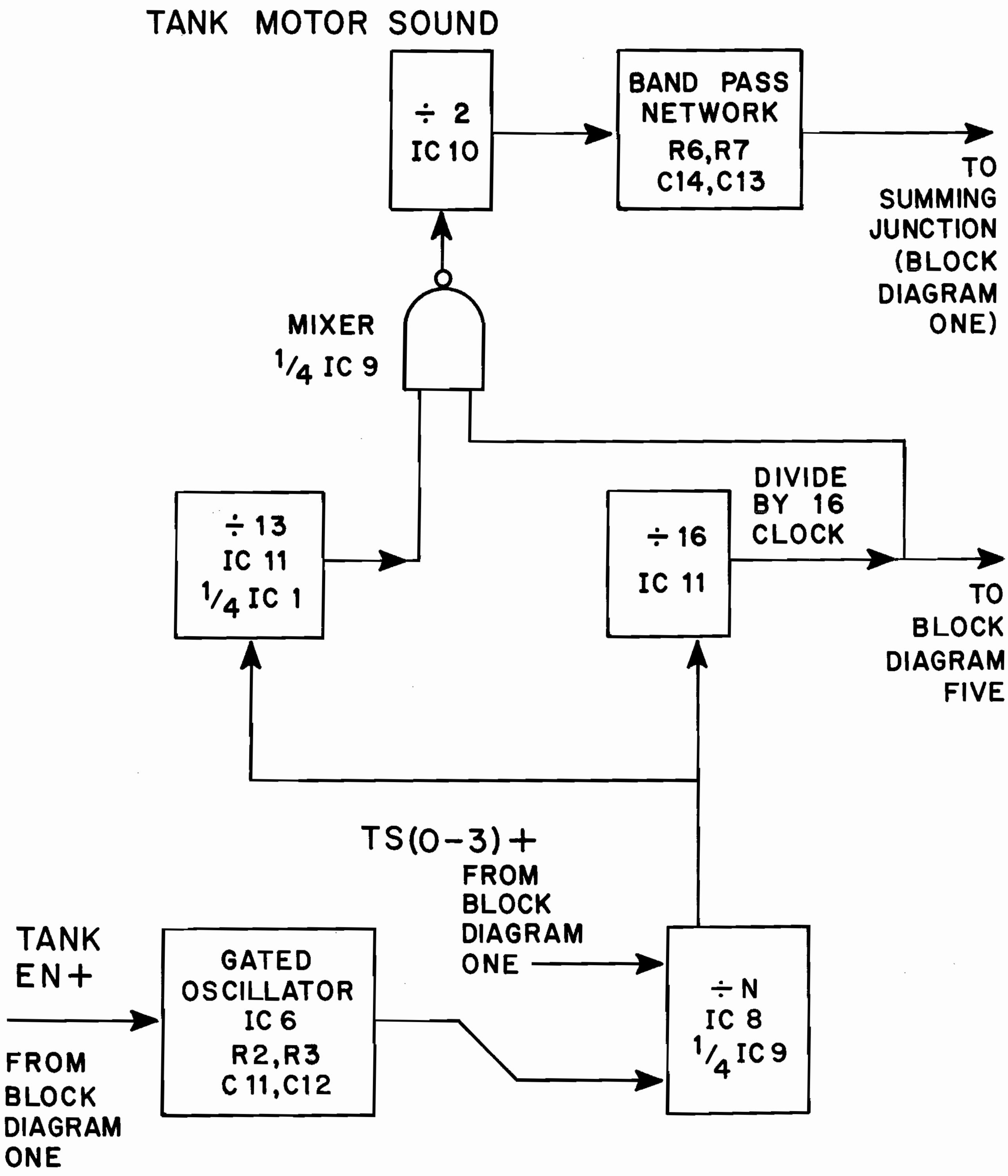
BLOCK DIAGRAM ONE



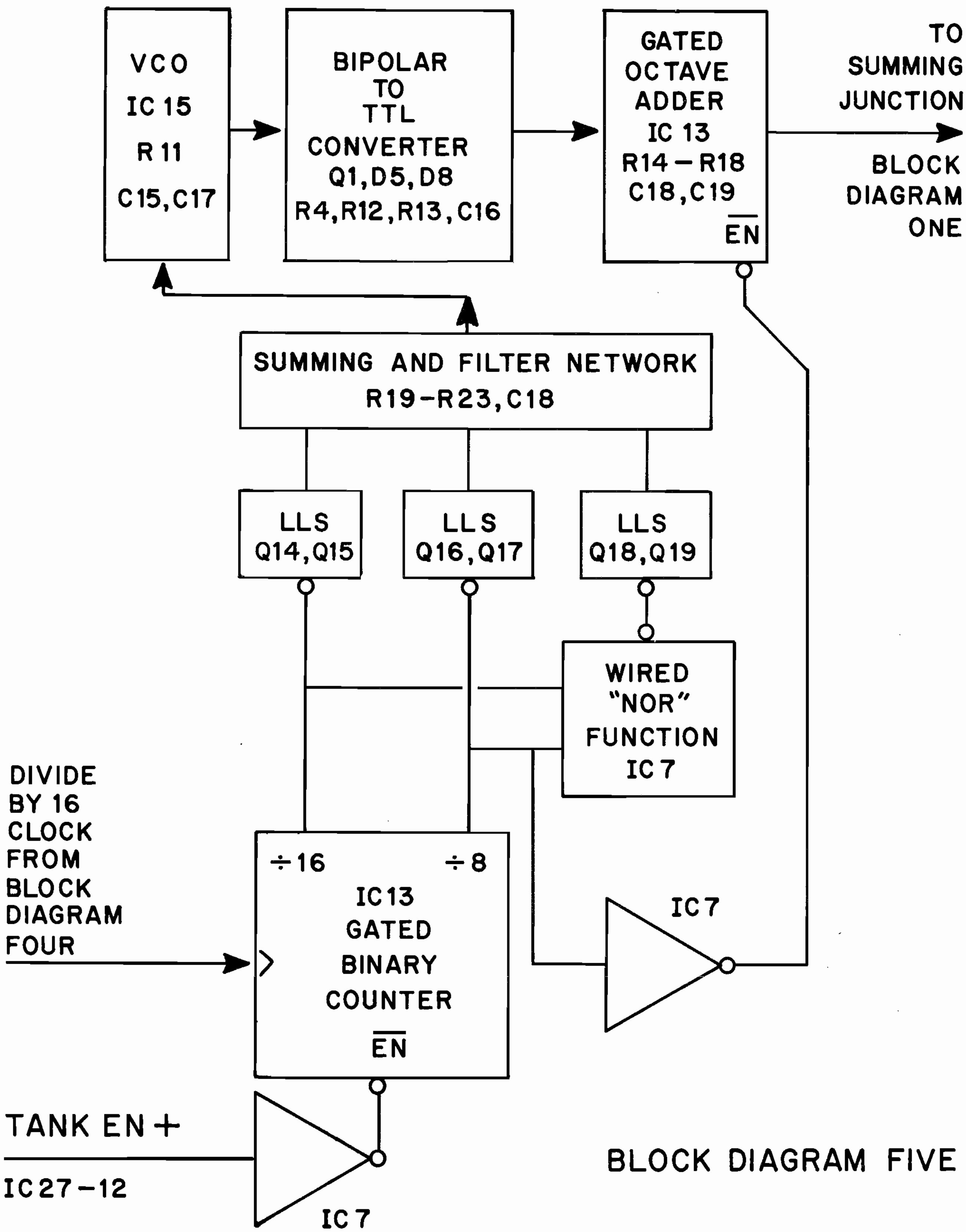
BLOCK DIAGRAM TWO



BLOCK DIAGRAM THREE



BLOCK DIAGRAM FOUR



BLOCK DIAGRAM FIVE

SECTION 7

TROUBLESHOOTING

UNIVERSAL BENCH TEST

CONFIGURATION

The components depicted in figure A represent the integral elements and interconnects necessary to effectively bench test the Cinematronics vector display video game system. The configuration is universal in that the game logic board A, display assembly B, and the power supply D are consistent from game to game. Audio board C varies in design for each new game though maintaining the pinout of its input power molex plug. Player control ribbon cable 3 terminates at the player control panel elements of each game (i.e. Joystick, Fire & Thrust buttons, Coin Acceptor Mechanism, etc.)

POWER INTERCONNECTS

The power supply D provides all voltages necessary for game operation.

Logic board drive is +5 volts ± 5% applied to pin 10 of the input power molex plug, & ground enters the logic board thru pin 4 to pins 1, 5, and 6. The logic board will free run in the game attract mode with proper power applied.

The audio board accepts +25 volts on pin4 and -25 volts applied thru pin 6 to pin 8. Ground enters pin 7 and is trace connected to speaker return pin 5. Pin 9 accepts +5 volts DC.

Power for the display is +25 volts thru pin 6 of its molex plug to pin 5 and -25 volts on pin 8. The CRT filament voltage of 6.3 V.A.C. enters the display electronics through pins 1 & 7 via a twisted pair of wires from the supply. A full wave rectified, unfiltered spot kill level of approximately +25 volts is applied to pin 14. The assembly is grounded thru pin 15 to pin 12.

SYSTEM TEST CONSIDERATIONS

As previously mentioned, the logic board A will free run in the particular game attract mode solely with +5 volt applied. Ribbon cables 1 & 2 are output lines and can be removed without affecting the free-run mode. Ribbon cable 3 is an input line and can also be removed for test purposes while free running.

The audio board C can be effectively diagnosed with proper power applied and a speaker. The logic board generates most sounds by grounding various control lines through ribbon cable 2. The cable can be removed and game sounds can be generated by tying these lines low temporarily with a jumper wire. Refer to the appropriate audio board schematic and theory of operation section.

The display assembly cannot be powered up without data cable 1 from the logic board connected. With the cable open or improper data being fed from the logic board, the circuit breakers CB1 & CB2 on the power supply will trip indicating a load in excess of 3a being drawn from the +25 and -25 volt lines. Testing of the monitor requires a functional logic board. While troubleshooting a no display condition, it is recommended to remove the 8 pin molded female plug from the neck of the CRT to protect the phosphor on the tube face from being burned by a high intensity spot.

TEST EQUIPMENT

For most test purposes, a wideband oscilloscope and a digital or analog multi-meter is adequate. Also, a tri-level logic probe for verifying the presence of digital information is recommended.

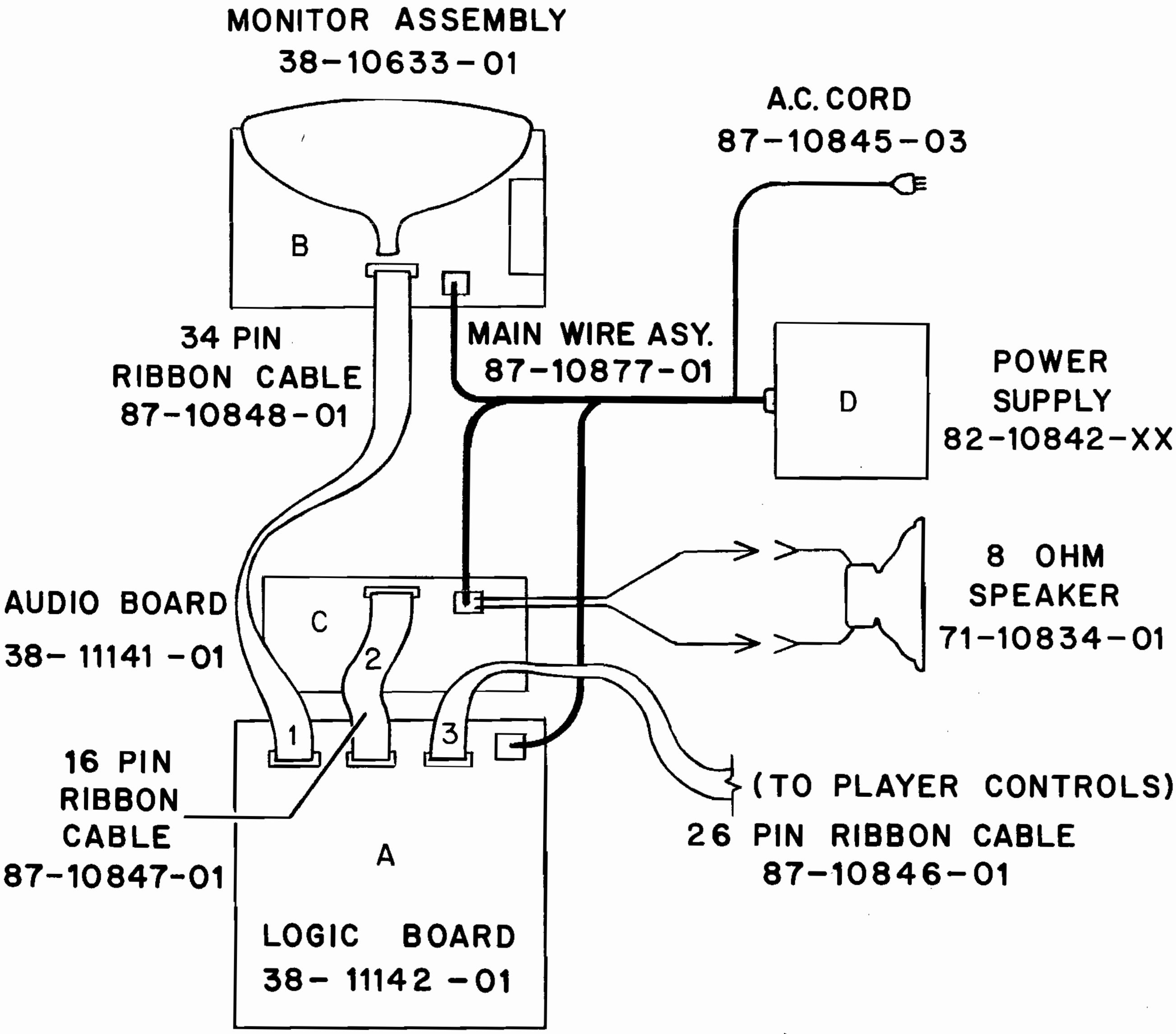
Testing and troubleshooting of the logic board is the least straightforward aspect of bench test. However, Cinematronics has

developed a logic board exerciser to be used in conjunction with a signature analyser that allows effective troubleshooting & repair with a minimum knowledge of microprocessor theory and operation. The exerciser puts a 4 bit alphanumeric code on each IC leg of each chip on the CPU board which then can be probed & read with the signature analyser to verify proper operation. Contact the customer service department at Cinematronics for details.

TEST PROCEDURES

The first step in effective bench testing is to review the system theory of operation included in the manual. Discussed are principles from the mathematical concept of vector systems to the actual hardware techniques employed in generating a vector video game display.

For specific troubleshooting procedures, refer to the symptom-remedy diagnostic chart included in the manual.



UNIVERSAL BENCH TEST CONFIGURATION

MONITOR PROBLEMS

Here is a systematic guide to trouble shooting a monitor that blows breakers. Monitor must be connected to a good CPU. Check for burned components. The first thing we want to do is be able to power up the monitor without blowing breakers - then do trouble shooting.

POWER OFF. Unplug yoke from monitor board. Unplug socket from CRT. POWER ON.

If breakers blow: POWER OFF. See 1.

If breakers hold: Check outputs of -15v, +15v, and +5v regulators. Output must be within ± 0.5 volt tolerance.

A. Use O-scope to check deflection circuits for proper signal. 1mv/div time base is a good scope setting. Between DAC-80 output and input of Q101 or Q201, signal amplitude is about ± 3 volts peak. DC component should be less than ± 200 mv. Too much DC component will trip breakers. If signal into Q101/Q201 is good, problem is in transistorized deflection amps. With yoke disconnected, a good amp will put out an odd looking "square wave", swinging between +25 volts. To check a bad deflection amp, check all transistors. Look for burned R118, R119, R113, R117 or R218, R219, R213, R217. R115, R116, R120, R121 may open with no burn marks. For test purposes, protection transistors Q106, Q107, Q206, Q207 may be removed from the circuit and amplifier can be powered up. Always replace protection transistors before returning monitor to normal service.

1. POWER OFF. Unplug heat sink wiring harnesses from monitor board. POWER ON.
Breakers blow: POWER OFF See 2.
Breakers hold: one or more of Q110, Q111, Q210, Q211 are shorted. Damage elsewhere is likely. Follow procedure at A.

2. Problem is most likely Video High Voltage module. Unplug from board and POWER ON. Breakers hold: replace or repair Video power supply. Breakers blow: Maybe a shorted tantalum capacitor. Or call us.

TABLE 7-1. TROUBLESHOOTING GUIDE

PROBLEM	PROBABLE SOLUTIONS
No Picture	Listen for audible "clatter" from the deflection yoke on the CRT neck. If the clatter is present, deflection circuitry is working and the problem is in the intensity circuit.
	No high voltage.
	If game audio is present, the CPU board is functional and the problem is in the monitor. If the audio is distorted or absent, the CPU board is suspect. If CPU board is equipped with red led near the input power plug, verify that it flashes once when power is applied and remains off thereafter. If no LED, verify that C8 pin 6 is constantly low with a voltmeter.
	Check the neck of the CRT for a glowing filament. If there is no glow, check the brown & black twisted pair of the CRT plug for 6.3 volts AC.
	Be sure all connections to the CPU board and monitor are firmly seated.
	Connect a scope to the yellow wire leading to the CRT connector. Set brightness full clockwise. There should be an 80-100 volt DC base with pulses dropping down to a 40 volt level. If no pulses, probe IC7 pin 4 with a scope and observe data pulses. If present, check Q2 & Q3 with an ohmeter or transistor tester.
	Check cathode of D5 for a full wave rectified, unfiltered voltage signal floating at +25 volts.
	Check seating of CRT plug. Remove and probe with scope to verify presence of proper signals.
Narrow Line on Display	Check IC1.
	Check for open yoke windings with ohmeter.
	Check for bad solder & crimp connections to yoke wires.
	Verify continuity between display board and heat sunk power transistors Q110, Q210, Q111 and Q211.
	Check Q110, Q210, Q111, Q211 with ohmeter or transistor tester. Inspect solder connections on circuit board molex connector socket pins.
Half Picture	Left Half: Check Q206, 208, 210 Right Half: Check Q207, 209, 211 Top Half: Check Q107, 109, 111 Bottom Half: Check Q106, 108, 110

TABLE 7-1. TROUBLESHOOTING GUIDE (Continued)

PROBLEM	PROBABLE SOLUTIONS
	Check solder connections on heat sink molex plugs J3 & J4. Check diodes CR109, 110, 111 Check diodes CR209, 210, 211 Check transistors Q105, Q205 Check resistors R116, R216.
No Brightness Control	Check intensity pot R111 for open wiper or internal short. Check for open capacitor C17. Check for bad solder connections to R111.
Picture on Display Jitters	Replace analog switch IC1. Check size pots R109 and R209 for wiper noise by turning briskly while observing the screen. Readjust for proper screen size. Check for bad solder connections on R109 & R209. Check DAC IC101 & IC201 for bad solder connections. Insure that all molex connectors are properly seated.
Suspect High Voltage too high/too low	An accurate High Voltage meter will read close to 16KV if high voltage is good. Self-contained HV meters vary widely in accuracy. If +90 and +400 volts out of high voltage supply are good, chances are 16KV is good. If +90 or +400 volts are bad, repair or replace high voltage supply.
Dotted Display	Check IC-7 pins 2, 4. Verify proper operation of IC1. Check for proper +25 and -25 volts DC. Check operation of DAC's IC101 and IC201. On logic board, check I 8 pin 2 for pulses. Verify presence at analog switch.
No Audio	Check for open speaker coil. Check transistors 2N6292 and 2N6107 and nearby output components on audio board with ohmeter or transistor checker. Check 7815 and 7915 outputs. Check for open wiper on volume control mounted on inside of coin door. Refer to audio board theory of operation and troubleshooting guide. Replace F2 on logic board.

TABLE 7-1. TROUBLESHOOTING GUIDE (Continued)

PROBLEM	PROBABLE SOLUTIONS
Coin Counter is Inoperative	Check 2N6292 transistor on logic board with ohmeter or transistor tester. Verify proper operation of A4 by grounding A4 pin 1. Coin counter should click. Disconnect coin counter molex connector. Measure DC voltage on red wire. Meter should read +25 volts DC.
Gives No Credits	Tie E4 pin 12 to ground. If credits fail to appear, replace E4. If credits appear, disconnect logic board ribbon connector J3. Measure +5 volts on A4 pins 1 & 5. If missing, replace pull up resistor pack C2. Alternately ground A4 pins 1 & 5. If credits appear, problem is in switches on coin door. Verify proper coin door microswitch operation. Reconnect J3. Observe A4 pins 3 & 6 alternately while depressing micro-switch lever on coin mechanism. Pins 3 & 6 should change states. Replace A4. Replace F2 (74LS259) on logic board.
Player Control Button(s) Inoperative	Refer to player control schematic in APPENDIX. Verify with ohmeter proper closure of player control leaf blade switches. Remove J3 connector. Measure +5 volts on D4 - 1, 2, 3, 4, 12, 13, 14, 15. If missing, replace D4. Replace pull up resistor pack D2. Measure +5 volts on C4 - 1, 2, 3, 4, 12, 13, 14, 15. If missing, replace C4. Replace pull up resistor pack C2. Coin up a game and, with J3 disconnected, ground aforementioned pins on C4 & D4. If display responds problem is in continuity from J3 to player control switches.

SECTION 8

SUGGESTED PARTS FOR STOCK

The following parts fail most frequently:

MONITOR

LF13331	—	Analog switch
2N5876	—	PNP output transistor
2N5878	—	NPN output transistor
2N5320	—	PNP driver transistor
2N5322	—	NPN driver transistor
7406	—	IC inverter package
2N5550	—	NPN transistor 140 volt BVceo
7805	—	+5 volt regulator IC
7815	—	+15 volt regulator IC
7915	—	-15 volt regulator IC

CPU

74LS259/DM8334	—	IC 8 bit latch
74LS32	—	IC or gate
D ROM 1	—	IC PROM
20101 A2	—	IC RAM 256 x 4

AUDIO

2N6107	—	PNP output transistor
2N6292	—	NPN output transistor
TL081/LF351	—	IC op-amp
CA3080	—	IC transconduct.
74LS377	—	IC octal D flip-flop (also used in CPU)

The following parts don't fail frequently, but are not readily available local electronic supply houses:

MONITOR

DAC-80	—	digital to analog converter

CPU

Masked ROMS	—	set of four contain game program
D ROMS (1-6)	—	custom made for CPU
25LS181	—	ALU

SECTION 8

PARTS LIST

OVERALL ASSEMBLY

10-11215-01

ITEM NO.	CINEMATRONICS PART NO.	DESCRIPTION	MFGR. PART NO.	QTY.
1	38-11145-01	Cabinet Assembly		1
2	38-11208-01	Control Panel Assembly		1
3	38-10642-01	Circuit Panel Assembly		1
		(CPU and Audio Boards)		1
4	38-10633-01	Monitor Assembly (Display Board)		1
5	38-10895-01	Power Supply Assembly		1
6	72-11211-01	Operators Manual		
		CABINET ASSEMBLY		
		38-11145-01		
1	32-10889-01	Cabinet		1
2	20-10871-01	Coin Box		1
3	20-10872-01	Coin Box Cover		1
4	20-10864-01	Coin Box Handle		1
5	20-10862-01	Coin Box Tongue BKT.		1
6	38-10897-01	Coin Door Assembly		1
7	38-10891-01	Coin Meter/Vol. Cntl. Assy.		1
8	20-10865-01	Cover Plate		1
9	22-10953-01	Display Shield		1
10	37-10893-01	Interlock Switch		1
11	20-10863-01	Interlock Switch BRKT.		1
12	20-10866-01	Rail, Left		1
13	20-10867-01	Rail, Right		1
14	20-10879-01	Retainer, Plexiglass		2
15	20-10530-01	Grill, Speaker		1
16	71-10834-01	Speaker		1
17	21-10831-01	Bezel, CRT		1
18	21-11203-02	CRT Plexiglass (Screened)		1
19	21-11202-02	Upper Plexiglass (Screened)		1
20	22-11199-01	Decal, Side left		1
	22-11200-01	right		1
21	26-10588-01	Fixture, Florescent Lamp		1
22	01-10505-01	Florescent Lamp		1
23	87-10877-01	Main Wire Harness		1
24	22-10542-01	Label, Patent Notice		1
25	22-10543-01	Label, Safety GND Notice		1
26	22-10544-01	Label, Unit Wired For:		1

ITEM	CINEMATRONICS PART NO.	DESCRIPTION	MFGR. PART NO.	QTY
28	25-10561-01	Wire Nuts		2
29	34-10903-01	Flat Braid 3/16"		20ft.
30	35-10618-01	Terminal, Ring Tongue (Braid)		8
31	25-10554-01	Carriage Bolt CN BX	3/16"-1¼" plated	4
32	25-10552-01	Carriage Bolt SPK, P.S., CN DR	3/16"-1½" Blk Ox	10
33	25-10553-01	Carriage Bolt CNTL PNL	3/16"-2" Blk Ox	2
34	25-10551-01	Carriage Bolt MNTR	3/16"-½" Blk Ox	4
35	25-10909-01	Carriage Bolt CN BX TNG	3/16"-¾" Blk Ox	1
36	25-10558-01	Hex Nut	10-24	17
37	25-10560-01	Wing Nut	10-24	4
38	25-10566-01	Wood Screw Bx Dr	#8-5/8" Blk Ox	19
39	25-10568-01	Washer, Flat	#10-½"	6
40	25-10569-01	Washer, Flat	#10-1"	2
41	25-10572-01	Washer, Lock	#10 Int. Th.	20

CONTROL PANEL ASSEMBLY

38-11208-01

ITEM	CINEMATRONICS PART NO.	DESCRIPTION	MFGR. PART NO.	QTY
1	32-11201-01	Control Panel, Wood		1
2	21-11106-02	Instruction Panel, Plex (Screened)		1
3	37-10623-01	Switch W/Mounting BRKT	WICO#15-0499-01	10
4	37-10624-01	Button Assembly, Long	WICO#15-0405-01	10
5	25-10559-01	Pal Nut	WICO#19-0254-01	10
6	20-10879-01	Retainer, Player Control		1
7	80-10840-01	Distribution P.C.B.		1
8	41-10645-01	Connector, Insulat. Displ. PCB 26 pin		1
9	87-10846-03	Ribbon Cable 26 wire		1
10	41-10646-01	Molex, Wafer Fric. Lock 3 cir.	09-65-1031	1
11	25-10578-01	Swage Spacer ¼"		2
12	25-10567-01	Wood screw #6-1" Blk. Ox Box Dr.		2
13	25-10566-01	Wood Screw #8-5/8" Blk. Ox. Box Dr.		3
14	87-10876-01	Switch Wire Harness Assembly		1
15	37-10957-01	Leaf Switch Replacement	WICO#15-0677-01	

ITEM	CINEMATRONICS PART NO.	DESCRIPTION	MFGR. PART NO.	QTY
		CIRCUIT PANEL ASSEMBLY		
		38-10642-01		
1	20-10525-01	Mounting Plate		1
2	38-11142-01	CPU P.C.B. Assembly		1
3	38-11141-01	Audio P.C.B. Assembly		1
4	87-10847-01	Ribbon Cable 16 pin		1
5	87-10848-01	Ribbon Cable 34 pin		1
6	25-10571-01	#6 Lock Washer Int. Th.		9
7	25-10563-01	6-32-½" M.S. Rd. Hd. PH.		9
		MONITOR ASSEMBLY		
		38-10633-01		
1	90-10860-01	CRT 19"	19VARP4	1
2	38-10631-01	Deflection Yoke Amplifier		1
3	38-10958-01	Monitor Assembly Test		Ref
4	38-10637-01	Yoke Assembly		1
5	82-10841-01	Keltron Video Power Supply		1
6	25-10583-01	Spring, CRT		1
7	20-10869-01	Mounting Bracket LH		1
8	20-10870-01	Mounting Bracket RH		1
9	38-10628-01	Display P.C.B. Assembly		1
10	25-10562-01	4-40-½" M.S. Pan Hd. PH.		3
11	25-10563-01	6-32-½" M.S. Pan Hd. PH.		3
12	25-10571-01	#6 Lock Washer INT. TH.		3
13	25-10557-01	6-32 Hex Nut		3
14	25-10564-01	#6-½" S.M.S. Hex Hd.		16
15	25-10568-01	#10-½" Wahser		4
16	25-10569-01	#10-1" Washer		4
17	25-10565-01	#10-½" S.M.S. Hex Hd.		4
18	20-10528-01	Chassis		1
19	38-10632-01	CRT Socket Assembly		Ref
20	21-11108-01	Overlay, Plastic (CRT)		1
21	44-10715-01	Analog Switch		1
22	22-10545-01	Label, Factory Adjust Only		1

ITEM	CINEMATRONICS PART NO.	DESCRIPTION	MFGR. PART NO.	QTY
		CRT SOCKET ASSEMBLY		
		38-10632-01		
1	36-10622-01	CRT Socket		1
2	63-10804-01	Capacitor .05mf 1600VDC	Sprague 16PS-S50	2
3	25-10582-01	Heat Shrink Tubing (clear)		AR
4	35-11205-01	Ring Tongue Terminal 22 GA		1
5	25-10564-01	#6-½" S.M.S. Hex Hd.		1
6	25-10579-01	TY RAP	T-18 R	2
7	34-10608-02	Wire 18 AWG 9"		2
		DEFLECTION YOKE AMPLIFIER		
		38-10631-01		
1	20-10522-01	Heat Sink	2107-A	2
2	66-10822-01	Transistor	2N5876	2
3	66-10823-01	Transistor	2N5878	2
4	87-10873-01	Heat Sink Harness Long		1
5	87-10874-01	Heat Sink Harness Short		1
6	22-10546-01	Label, Warning		1
7	45-10719-01	Washer, MICA Greaseless		4
8	25-10563-01	6-32-½" Rd. Hd. Ph. M.S.		3
		YOKE ASSEMBLY		
		38-10637-01		
1	40-10644-01	Yoke, Broy	746	1
2	35-10615-01	Molex, Female Pins	02-09-1118	3
3	35-10614-01	Molex, Male Pins	02-09-2118	1
4	41-10657-01	Molex, Receptacle 6 Cir.	03-09-1063	1
		POWER SUPPLY ASSEMBLY		
		38-10895-01		
1	82-10842-**	Power Supply		1
	82-10842-40	National Power Technology		2
	82-10842-20	CONDOR		2

ITEM	CINEMATRONICS PART NO.	DESCRIPTION	MFGR. PART NO.	QTY
		MAIN WIRE HARNESS ASSEMBLY		
		87-10877-01		
1	41-10883-01	Molex Receptacle 3 Cir.	03-09-1038	2
2	41-10658-01	Molex Receptacle 4 Cir.	03-09-1042	1
3	41-10649-02	Molex Receptacle 9 Cir.	03-09-1093	1
4	41-10647-01	Molex Receptacle 12 Cir.	03-09-1122	2
5	41-10648-01	Molex Plug 15 Cir.	03-09-2153	1
6	35-10615-01	Molex Femal Socket	02-09-1118	21
7	35-10614-01	Molex Male Pin	02-09-2118	21
8	35-10617-01	Terminal, Female QK DSCT		2
9	25-10579-01	TY RAPS	T-18 R	23
10	25-10580-01	TY RAPS W/Eyelet 63/4		6
11		Wire		Ref
12	87-10845-01	A.C. Cord		Ref
13	35-10614-01	Terminal, Molex Male Pin	02-09-2118	3
		COIN SWITCH HARNESS ASSEMBLY		
		87-10876-01		
1	41-10650-01	Molex, Connector W/Lock 3 Cir.	09-50-3031	1
2	35-10880-01	Molex, Female Crimp Terminal	08-50-0106	3
3	35-10617-01	Terminal, Female Quick Disconnect .187-.032		6
4		Wire 5 Pcs.		Ref
5	25-10579-01	Tie Wraps	T-18 R	8
		COIN METER/VOL. CONTROL ASY.		
		38-10891-01		
1	20-10868-11	Bracket, Coin Meter/Vol.		1
2	38-10960-01	Coin Meter Assembly		1
3	38-10961-01	Volume Control Harness Assembly		1
4	25-10562-01	#4-40-½" M.S. Rd. Hd. Ph.		2
5	25-10556-01	HEX Nut 4-40		2
6	25-10570-01	Washer, Lock #4		2
		COIN METER ASSEMBLY		
		38-10960-01		
1	29-10590-01	Coin Meter		1
2	65-10812-01	Diode	1N4003	1
3	35-10615-01	Molex, Female Pin	02-09-1118	2
4	41-10659-01	Molex, Plug 3 Cir.	03-09-2038	1

ITEM	CINEMATRONICS PART NO.	DESCRIPTION	REF. DES.	MFGR. PART NO.	QTY
		VOLUME CONTROL HARN. ASY.			
		38-10961-01			
1	51-10722-01	Pot. 10K			1
2	41-10659-01	Molex Plug 3 Cir.		03-09-2038	1
3	35-10615-01	Molex Female Socket		02-09-1118	2
4	35-10614-01	Molex Male Pin		02-09-2118	1
5	25-10579-01	TY RAPS		T-18 R	3
6		Wire			Ref
7	26-10589-01	Knob			1
		COIN DOOR ASSEMBLY			
		38-10897-01			
1	20-10896-01	Coin Door			1
2	20-10868-01	Bracket, Coin Meter/Volume			1
3	25-10905-01	Cable Clamps 3/16"			5
4	87-10876-01	Wire Harness, Coin Switch			
5	87-10955-01	Wire Harness, Volume Control			
6	25-10556-01	Hex Nut		4-40	3
7	25-10570-01	Washer, Lock Int. Th.		#4	3
8	25-10563-01	6-32-½" Rd. Hd. Ph. M.S.			2
9	25-10571-01	#6 Lock Washer Int. Th.			2
10	25-10557-01	6-32 Hex Nut			2
11	22-10899-01	Decal			1
		SWITCH WIRE HARNESS ASY.			
		87-10876-01			
1		Wire List			Ref
2	25-10579-01	TY RAPS		T-18 R	7
		CPU P.C.B. ASSEMBLY			
		38-11142-01			
1	44-10676-01	I.C. ALU	L6, M6, N6	25LS181	3
2	44-10677-01	I.C. NAND Gate	A4, A10, B4, J6	74LS00	4
3	44-10678-01	I.C. NOR Gate	A6, D10, H8, K4	74LS02	4
4	44-10679-01	I.C. Hex Inverter	B6, E12, I8	74LS04	3
5	44-10680-01	I.C. AND Gate	C10, I6	74LS08	1
6	44-10681-01	I.C. NAND Gate	B12, F4, L2	74LS10	3
7	44-10682-01	I.C. NOR Gate	C12, D12, F6	74LS27	3

ITEM NO.	CINEMATRONICS PART NO.	DESCRIPTION	REF. DES.	MFGR. PART NO.	QTY.
8	44-10683-01	I.C. OR Gate	A12, B10, J2, K2	74LS32	4
9	44-10684-01	I.C. Quad D Latch	T9, U9	74LS75	2
10	44-10685-01	I.C. Mag Comparator	L9, M9, N9	74LS85	3
11	44-10686-01	I.C. Exclusive OR	J8	74LS86	1
12	44-10687-01	I.C. Dual J-K Flip Flop	A8, B2, B8, C8, G4, G8, J10	74LS107	7
13	44-10688-01	I.C. 1 of 8 Data Selectors	C4, D4, E4, F10	74LS151	4
14	44-10689-01	I.C. Quad Data Selector	L11, M11, N11, P9, R9, S9, T11, U11	74LS157	8
15	44-10690-01	I.C. Binary Counter	C6, D6, E6, E10, F8, I14, P11, R11, S11	74LS163	9
16	44-10691-01	I.C. 8 Bit Shift Regist	H6	74LS164	1
17	44-10692-01	I.C. 4 Bit Shift Regist	G10, H12, N4, M4 P4, P13, R4, S4, T4	74LS194	9
18	44-10693-01	I.C. Tri-State Quad	N2, R2, T2	74LS257	3
19	44-10694-01	I.C. 8 Bit Latch	F2	74LS259/ DM8334	1
20	44-10695-01	I.C. Quad 2-Input Multi.	I12, J12	74LS298	2
21	44-10696-01	I.C. Octal D Flip Flop	M2, P2, R13, S2, S13, T13	74LS377	6
22	44-10697-01	I.C. Dual 4 Bit Counter	H4, I4	74LS393	2
23	44-10698-01	I.C. NAND Gate	A2, I10	74S00	2
24	44-10699-01	I.C. NOR Gate	H14	74S02	1
25	44-10700-01	I.C. Hex Inverter	I2, U2	74S04	2
26	44-10701-01	I.C. AND Gate	A14	74S08	1
27	44-10703-01	I.C. OR Gate	B14, H10	74S32	2
28	44-10704-01	I.C. Dual J-K Flip Flop	G2, H2	74S113	2
29	44-10705-01	I.C. Quad 2 to 1 Data Sel.	G14	74S158	1
30	44-10706-01	I.C. Look Ahead Carry	L4	74S182	1
31	44-10671-01	I.C. Dual 4 in NOR Gate	F12	7425	1
32	44-10675-01	I.C. Quad Comp. Output	J4	74265	1
33	44-10702-01	I.C. Triple 3 in NAND	G12	74S10	1
34	44-10667-01	I.C. RAM 256x4	L14, M14, N14	2101A2	3
35	44-10707-01	I.C. PROM DROM 1	F14	2085	1
36	44-10708-01	I.C. PROM DROM 2	E14	2086	1
37	44-10709-01	I.C. PROM DROM 3	D14	2087	1
38	44-10710-01	I.C. PROM DROM 4	C14	2088	1
39	44-10711-01	I.C. PROM DROM 5	E8	2089	1
40	44-10712-01	I.C. PROM DROM 6	J14	2090	1
41	38-11210-01	I.C. E-PROM		2732	4
42					
43	37-10625-01	7 Pole Dip Switch	E2		1
44	69-10833-01	Crystal 20 MHz	L1		1
45	65-10811-01	Diode	CR1, CR2	1N914 B	2
46	66-10816-01	Transistor	Q2, Q3	2N3904	2
47	66-10825-01	Transistor	Q1	2N6292	1

ITEM NO.	CINEMATRONICS PART NO.	DESCRIPTION	REF. DES.	MFGR. PART NO.	QTY.
48	63-10783-01	Cap Disk .02mf 50V	C1-C58		58
49	63-10785-01	Cap Disk 680pf 100V	C59		1
50	63-10808-01	Cap Tant Dip 3.3mf 35V	C62		1
51	63-10810-01	Cap Tant Dip 22mf 35V	C61		1
52	53-10731-01	Resistor, 330 ohm ¼W 5%C	R2, R3		2
53	53-10732-01	Resistor, 470 ohm ¼W 5%C	R5		1
54	53-10734-01	Resistor, 1K ohm ¼W 5%C	R1, R4, R6, R7, R8, R9, R10, R11, R17, R18, R19, R20		12
55	53-10738-01	Resistor 2.2K ohm ¼W 5%C	R15		1
56	53-10746-01	Resistor 10K ohm ¼W 5%C	R13, R16		2
57	53-10753-01	Resistor 30K ohm ¼W 5%C	R12		1
58	53-10762-01	Resistor 560K ohm ¼W 5%C	R14		1
59	53-10779-01	Resistor Dip Pak 1K	C2, D2		2
60	35-10616-01	Test Points			6
61	41-10655-01	Molex, Wafercon 12 Cir	J1	09-18-5127	1
62	41-10652-01	Male Header PCB 16 Pin	J4		1
63	41-10653-01	Male Header PCB 26 Pin	J3		1
64	41-10654-01	Male Header PCB 34 Pin	J2		1
65	34-10612-06	Jumpers,	D8, U14		2
66	36-10619-01	Socket, Dip 14 Pin	F6		1
67	36-10620-01	Socket, Dip 16 Pin	D8, F14, U14		3
68	36-10621-01	Socket, Dip 24 Pin	L6, M6, N6, P7, R7, T7, U7		7
69	80-10837-01	Printed Circuit Board			1
70	53-10726-01	Resistor, 100 ohm ¼W 5%C	R21		1
71	65-10814-01	L.E.D.			1
		DISPLAY P.C.B. ASY.			
		38-10628-01			
1	53-10723-01	Resistor, 15 ohm ¼W 5%C	R11, R215		2
2	53-10724-01	Resistor 33 ohm ¼W 5%C	R116, R216		2
3	53-10725-01	Resistor, 47 ohm ¼W 5%C	R108, R130, R131, R210, R230, R231		6
4	53-10726-01	Resistor, 100 ohm ¼W 5%C	R110, R117, R208, R217		4
5	53-10729-01	Resistor, 200 ohm ¼W 5%C	R113, R213		2
6	53-10731-01	Resistor, 330 ohm ¼W 5%C	R207		1
7	53-10732-01	Resistor, 470 ohm ¼W 5%C	R1, R2, R4, R5, R19		5
8	53-10733-01	Resistor, 820 ohm ¼W 5%C	R130, R230, R112, R212		4

ITEM NO.	CINEMATRONICS PART NO.	DESCRIPTION	REF. DES.	MFGR. PART NO.	QTY.
9	53-10734-01	Resistor 1K ohm ¼W 5%C	R20, R24		2
10	53-10736-01	Resistor, 1.8K ohm ¼W 5%	R104		1
11	53-10738-01	Resistor, 2.2K ohm ¼W 5%C	R9, R204		2
12	53-10740-01	Resistor, 3K ohm ¼W 5%C	R105, 107, 205		3
13	53-10744-01	Resistor, 5.6K ohm ¼W 5%C	R10, R206		2
14	53-10746-01	Resistor, 10K ohm ¼W 5%C	R6, R22, R23, R26, R106		5
15	53-10758-01	Resistor, 68K ohm ¼W 5%C	R25		1
16	53-10766-01	Resistor, 47ohm ½W 5%C	R118, R119, R218, R219		4
17	53-10767-01	Resistor, 2.2K ohm ½W 5%C	R21		1
18	53-10768-01	Resistor, 8.2K ohm ½W 5%C	R111, R114, R211, R214		4
19	53-10769-01	Resistor, 10K ohm ½W 5%C	R3		1
20	53-10770-01	Resistor, 2.7 ohm 1W 5%C	R124-R129, R224-R229		12
21	53-10771-01	Resistor, 360 ohm 1W 5%C	R123, R223		2
22	53-10772-01	Resistor, 10K ohm 1W 5%C	R7, R8		2
23	53-10773-01	Resistor, 100 ohm 2W 5%C	R27		1
24	53-10774-01	Resistor, .18 ohm 3W 5%C	R120, R121, R220, R221		4
25	53-10776-01	Resistor, 1.43K ohm ¼W 1%	MF R101		1
26	53-10777-01	Resistor, 2.1K ohm ¼W 1% MF	R201		1
27	53-10778-01	Resistor, 10K ohm ¼W 1% MF	R103, R203		2
28	51-10720-01	Trimpot, 100 ohm	R109, R209		2
29	51-10721-01	Trimpot, 5K ohm	R102, R202		2
30	65-10811-01	Diode	D17, D19, D20 D101-D104, D201-D204	1N914 B	11
31	65-10812-01	Diode	D3, D4, D5, D12, D13, D15, D16, D18 D105-D115, D205-D215	1N4003	31
32	44-10669-01	I.C. Hex Inverter O.C.	IC 7	7406	1
33	44-10672-01	I.C. Regulator +5V	IC 8	7805	1
34	44-10673-01	I.C. Regulator +15V	IC 4	7815	1
35	44-10674-01	I.C. Regulator -15V	IC 6	7915	1
36	44-10718-01	I.C. OP. AMP.	IC 102, 202	TL081 P/LF351	2
37	44-10714-01	I.C. Digitial Analog Con	IC 101, 201		2
38	66-10815-01	Transistor	Q105, Q106, Q205, Q206	2N2102	4
39	66-10816-01	Transistor	Q2, Q7, Q8	2N3904	3
40	66-10817-01	Transistor	Q107, Q207	2N3906	2

ITEM NO.	CINEMATRONICS PART NO.	DESCRIPTION	REF. DES.	MFGR. PART NO.	QTY.
41	66-10818-01	Transistor	Q6, Q101, Q102, Q103, Q201, 202, 203	2N5210	7
42	66-10819-01	Transistor	Q108, Q208	2N5320	2
43	66-10820-01	Transistor	Q104, Q109, Q204, Q209	2N5322	4
44	66-10821-01	Transistor	Q1, Q3	2N5550	2
45	63-10781-01	Cap Disk .005mf 50V	C8, C9		2
46	63-10784-01	Cap Disk .1mf 50V	C24, C27, C103, C104, C203, C204		6
47	63-10786-01	Cap Disk .1mf 100V	C102, C202		2
48	63-10799-01	Cap Film .33mf 35V	C1		1
49	63-10802-01	Cap Polycarb .022mf 200V	C101, C201		2
50	63-10805-01	Cap Dip Tant .47mf 35V	C25		1
51	63-10806-01	Cap Dip Tant 1mf 35V	C12, C13		2
52	63-10807-01	Cap Dip Tant 2.2mf 35V	C4, C10, C15, C23, C105		5
53	63-10809-01	Cap Dip Tant 4.7mf 35V	C26		1
54	63-10790-01	Cap Elect 47mf 50V	C205, C207		2
55	36-10620-01	Socket 16 Pin			1
56	35-10613-01	Molex, Male Pin Sold Tail		02-09-2134	8
57	41-10660-01	Molex, Receptacle 15 Cir	J2	03-09-1152	1
58	41-10661-01	Molex, Wafercon 6 Cir	J5	09-18-5061	1
59	41-10662-01	Molex, Wafercon 6 Cir	J3	09-18-5062	1
60	41-10663-01	Molex, Wafercon 6 Cir	J4, J6 K	09-18-5069	2
61	41-10654-01	Male Header PCB 34 Pin	J1		1
62	80-10902-01	Printed Circuit Board			1
63	01-10506-01	Neon Lamp	Lt 1, Lt 2	NE-2	2
64					
65	51-10722-01	10K Pot.	R11	JAINO56103UA	1
66	20-10523-01	Heat Sink Thermalloy		22030 B	6
67	20-10524-01	Heat Sink Thermalloy		6045 B	1
68		Wire			Ref
		AUDIO P.C.B. ASSEMBLY 38-11141-01			
1	20-10520-01	Heat Sink, Therm	"Refer To Assembly Drawings"	6071B	4
2	20-10521-01	Heat Sink, Therm		6072B	2
3	23-10548-01	Thermal Compound		DOW 340	
4	25-10556-01	Hex Nut		4-40	6
5	25-10570-01	Lockwasher		#4 Internal	6
6	25-10974-01	Machine Screw		4-40-3/8PNHDPH	6
7	41-10652-01	Header, 16 Pin		609-1622 M	1
8	41-10656-01	Conn, Molex 9 Cir		09-18-5094	1

ITEM NO.	CINEMATRONICS PART NO.	DESCRIPTION	REF. DES.	MFGR. PART NO.	QTY.
9	44-10669-01	IC		7406	1
10	44-10670-01	IC		7414	2
11	44-10673-01	IC		7815-C	1
12	44-10674-01	IC		7915-C	1
13	44-10677-01	IC		74LS00	1
14	44-10690-01	IC		74LS163	2
15	44-10691-01	IC		74LS164	1
16	44-10696-01	IC		74LS377	1
17	44-10697-01	IC		74LS393	2
18	44-10713-01	IC		CA3080E	4
19	44-10716-01	IC		LM555	2
20	44-10717-01	IC		AMI S2688	1
21	44-10718-01	IC		TL081P	4
22	44-10913-01	IC		LM566	1
23	53-10727-01	Resistor, ¼W 5% C		150 OHM	2
24	53-10734-01	Resistor, ¼W 5% C		1K OHM	10
25	53-10737-01	Resistor, ¼W 5% C		2K OHM	3
26	53-10739-01	Resistor, ¼W 5% C		2.7K OHM	13
27	53-10743-01	Resistor, ¼W 5% C	"Refer To Assembly Drawings"	4.7K OHM	8
28	53-10745-01	Resistor, ¼W 5% C		8.2K OHM	3
29	53-10746-01	Resistor, ¼W 5% C		10K OHM	2
30	53-10747-01	Resistor, ¼W 5% C		12K OHM	9
31	53-10748-01	Resistor, ¼W 5% C		15K OHM	1
32	53-10749-01	Resistor, ¼W 5% C		20K OHM	4
33	53-10750-01	Resistor, ¼W 5% C		22K OHM	6
34	53-10751-01	Resistor, ¼W 5% C		24K OHM	1
35	53-10753-01	Resistor, ¼W 5% C		30K OHM	2
36	53-10754-01	Resistor, ¼W 5% C		39K OHM	8
37	53-10755-01	Resistor, ¼W 5% C		43K OHM	1
38	53-10756-01	Resistor, ¼W 5% C		47K OHM	1
39	53-10759-01	Resistor, ¼W 5% C		82K OHM	1
40	53-10760-01	Resistor, ¼W 5% C		330K OHM	1
41	53-10764-01	Resistor, ¼W 5% C		1M	1
42	53-10765-01	Resistor, ¼W 5% C		1.5M OHM	2
43	53-10917-01	Resistor, ¼W 5% C		620 OHM	2
44	53-10918-01	Resistor, ¼W 5% C		2.4K OHM	3
45	53-10922-01	Resistor, ¼W 5% C		7.5K OHM	1
46	53-10923-01	Resistor, ¼W 5% C		18K OHM	1
47	53-10926-01	Resistor, ¼W 5% C		51K OHM	1
48	53-10928-01	Resistor, ¼W 5% C		100K OHM	1
49	53-10932-01	Resistor, ¼W 5% C		240K OHM	2
50	53-10936-01	Resistor, ¼W 5% C		390K OHM	3
51	53-11102-01	Resistor, 5W 5% C		.51 OHM	2
52	53-11129-01	Resistor, ¼W 5% C		680 OHM	2
53	53-11130-01	Resistor, ¼W 5% C		750 OHM	4
54	53-11131-01	Resistor, ¼W 5% C		1.3K OHM	2
55	53-11132-01	Resistor, ¼W 5% C		3.6K OHM	1
56	53-11133-01	Resistor, ¼W 5% C		16K OHM	1
57	53-11134-01	Resistor, ¼W 5% C		150K OHM	1

ITEM NO.	CINEMATRONICS PART NO.	DESCRIPTION	REF. DES.	MFGR. PART NO.	QTY.
58	53-11135-01	Resistor, ¼W 5% C	"Refer To Assembly Drawings"	220K OHM	1
59	53-11136-01	Resistor, ¼W 5% C		430K OHM	1
60	53-11137-01	Resistor, ¼W 5% C		750K OHM	1
61	53-11138-01	Resistor, ¼W 5% C		910K OHM	2
62	63-10780-01	Capacitor, Disk		470PF 50V	3
63	63-10781-01	Capacitor, Disk		.005MF 50V	1
64	63-10782-01	Capacitor, Disk		.01MF 50V	2
65	63-10784-01	Capacitor, Disk		.1MF 50V	24
66	63-10796-01	Capacitor, Film		.047MF 35V	5
67	63-10799-01	Capacitor, Film		.33MF 35V	1
68	63-10940-01	Capacitor, Disk		.001MF 50V	1
69	63-10941-01	Capacitor, Elect Rad		2.2MF 35V	2
70	63-10942-01	Capacitor, Elect Rad		3.3MF 35V	1
71	63-10944-01	Capacitor, Elect Rad		100MF 35V	1
72	63-10946-01	Capacitor, Film		.0047MF 100V	2
73	63-10948-01	Capacitor, Film		.1MF 100V	5
74	63-10949-01	Capacitor, Film		.22MF 35V	4
75	63-10951-01	Capacitor, Film		.47MF 100V	1
76	63-10952-01	Capacitor, Film		.68MF 100V	1
77	63-11127-01	Capacitor, Film		1.0MF 50V	1
78	63-11128-01	Capacitor, Film		22MF 50V	5
79	65-10811-01	Diode		1N914B	2
80	65-10812-01	Diode		1N4003 Plast	6
81	66-10816-01	Transistor		2N3904	4
82	66-10817-01	Transistor		2N3906	13
83	66-10824-01	Transistor		2N6107	1
84	66-10825-01	Transistor		2N6292	1
85	80-11140-01	P.C. Board			

APPENDIX A

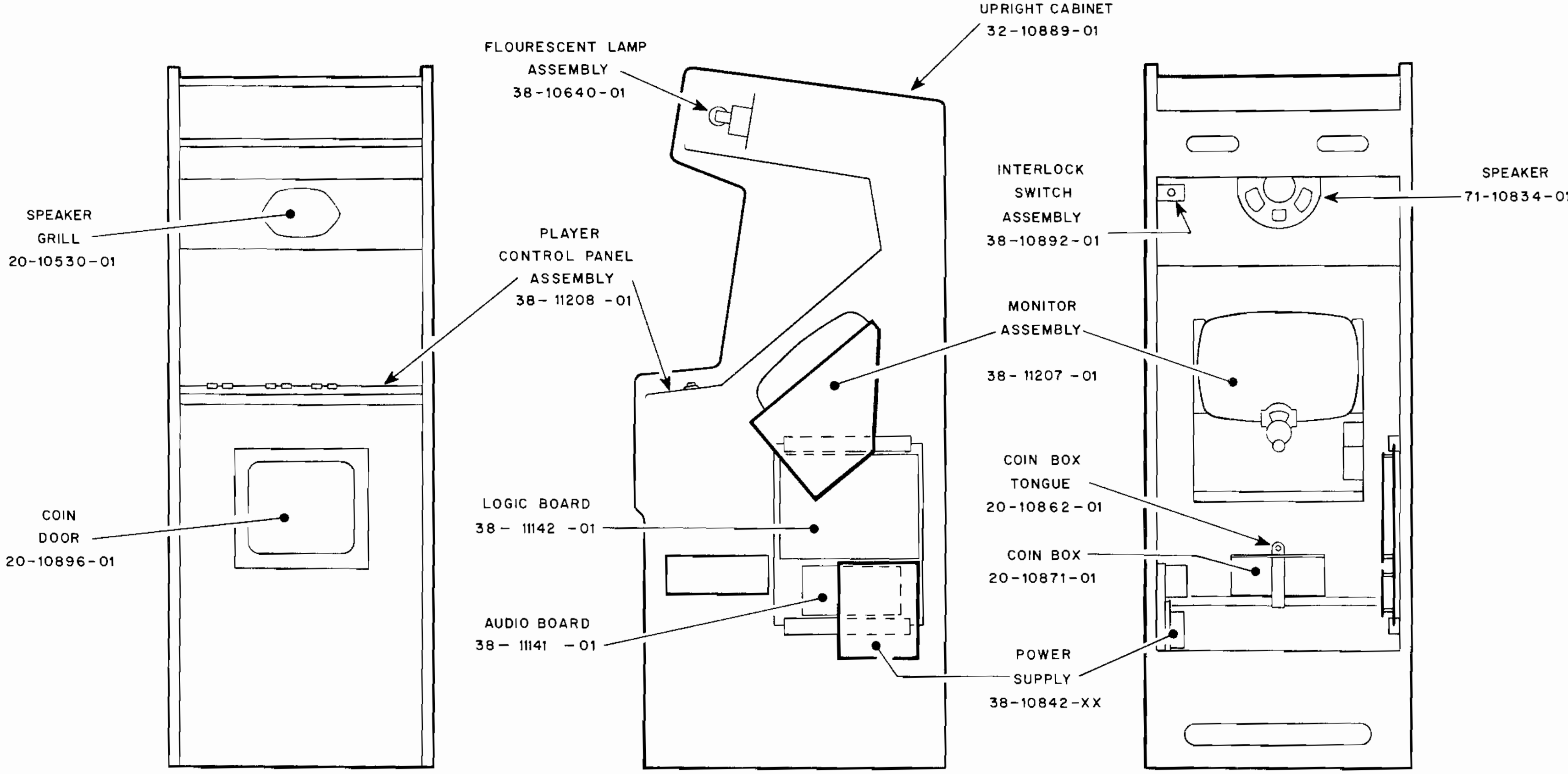
Assembly Drawings
Schematics
and
Wiring Diagrams

TABLE OF CONTENTS

ASSEMBLY DRAWINGS

SCHEMATICS
AND
WIRING DIAGRAMS

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED



NOTES: UNLESS OTHERWISE SPECIFIED

MATERIAL	DRAWN BY: dave scott	DATE	CINEMATRONICS INC El Cajon Ca. 92020
	PROJECT ENGR:	DATE	DWG TITLE: CABINET
	RELEASE APPROV:	DATE	
FINISH	DO NOT SCALE DWG		
	TOLERANCE UNLESS OTHERWISE SPECIFIED		MODEL NO / DWG SIZE D / DWG NO. 72-10889-01 / REV B
	PROJECTION	SCALE	CODE IDENT. / SHEET 1 OF 1

A1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
		8-21-80	

WIRE LIST

CONNECTOR	FROM	TO	COLOR	AWG.	PIN	LENGTH	REMARKS
POWER SUPPLY H1 MOLEX 03-09-1042	H1-1	LAMP	BLACK	18	MALE	87	TWISTED 1 PER INCH
	H1-2	LAMP	WHITE	18	"		
	H1-3						NOT USED
	H1-4						NOT USED
POWER SUPPLY H2 MOLEX 03-09-1122	H2-1	H9-GRN	GREEN				
	H2-2	H9-WT	WHITE				
	H2-3	H8-N.O.	RD/BLK	18	MALE	56	
	H2-4	H3-1	BROWN	22	"	52	TWISTED-1 PER INCH-6.3 VAC
	H2-5	H3-7	WHITE	22	"		
	H2-6	H3-14	YELLOW	22	"	52	SPOT KILL
	H2-7	H3-6	RED	18	"	52	+25
	H2-7	H4-4	RED	22	"	54	+25
	H2-8	H3-8	BLUE	18	"	52	-25
	H2-8	H4-6	BLUE	22	"	52	-25
	H2-9	H3-13	ORANGE	22	"	52	+5
	H2-9	H4-9	ORANGE	22	"	52	+5
	H2-10	H6-10	ORANGE	18	"	56	+5
	H2-11	H3-15	BLACK	18	"	52	GND
	H2-11	H4-7	BLACK	18	"	52	GND
	H2-12	H6-4	BLK/WT	18	"	56	GND
DISPLAY H3 MOLEX 03-09-2153	H3-1	H2-4	BROWN		FEMALE		REF. 6.3 VAC
	H3-2						NOT USED
	H3-3						NOT USED
	H3-4						NOT USED
	H3-5						NOT USED
	H3-6	H2-7	RED		FEMALE		REF. +25
	H3-7	H2-5	WHITE		"		REF. 6.3 VAC
	H3-8	H2-8	BLUE		"		REF. -25
	H3-9						NOT USED
	H3-10						NOT USED
	H3-11						NOT USED
	H3-12	H6-5	BLK/YEL	18	FEMALE	47	GND
	H3-13	H2-9	ORANGE		"		REF. +5
	H3-14	H2-6	YELLOW		"		REF. SPOT KILL
	H3-15	H2-11	BLACK		"		REF. GND

WIRE LIST

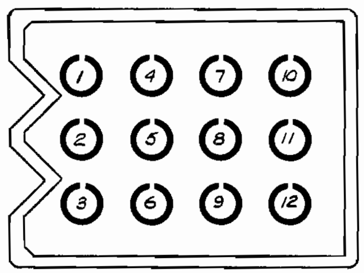
CONNECTOR	FROM	TO	COLOR	AWG.	PIN	LENGTH	REMARKS
AUDIO H4 MOLEX 03-09-1093	H4-1	H7-1	GREEN	22	MALE	33	VOLUME
	H4-2	SPEAKER	GREEN	22	FEMALE	71	SEE NOTE 4
	H4-3	H7-2	RED	22	"	33	VOLUME
	H4-4	H2-7	RED		"		REF. +25
	H4-4	H5-1	RED	22	"	35	
	H4-5	SPEAKER	BLACK	22	"	71	SEE NOTE 4
	H4-6	H2-8	BLUE		"		REF. -25
	H4-7	H2-11	BLACK		"		REF. GND
	H4-8	H7-3	BLUE	22	"	33	VOLUME
	H4-9	H2-9	ORANGE		"		REF. +5
COIN METER H5 MOLEX 03-09-1038	H5-1	H4-4	RED		MALE		REF.
	H5-2						NOT USED
	H5-3	H6-3	BROWN		MALE		REF.
LOGIC H6 MOLEX 03-09-1122	H6-1						NOT USED
	H6-2						NOT USED
	H6-3	H5-3	BROWN	22	FEMALE	27	METER
	H6-4	H2-12	BLK/WT		MALE		REF. GND
	H6-5	H3-12	BLK/YEL		FEMALE		REF. GND
	H6-6						NOT USED
	H6-7						NOT USED
	H6-8						NOT USED
	H6-9						NOT USED
	H6-10	H2-10	ORANGE		FEMALE		REF. +5
	H6-11						NOT USED
	H6-12						NOT USED
VOLUME H7 MOLEX 03-09-1038	H7-1	H4-1	GREEN		FEMALE		REF. TWISTED
	H7-2	H4-3	RED		MALE		
	H7-3	H4-8	BLUE		"		
INTERLOCK H8	H8-COM	H9-BLK	BLK/YEL	18	FQD		
	H8-N.O.	H2-3	RD/BLK		FQD		
AC LINE CORD H9	H9-GRN	H2-1		18x3	MALE		96" LONG WITH PLUG
	H9-WT	H2-2			MALE		
	H9-BLK	H8-COM			W/N		

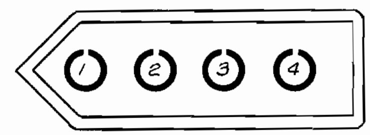
NOTES: UNLESS OTHERWISE SPECIFIED
1. LENGTHS GIVEN FOR TWISTED WIRE ARE AFTER TWISTING.
2. W/N - THIS CONNECTION MADE WITH WIRE NUT
3. FQD - FEMALE QUICK DISCONNECT
4. TERMINATE SPEAKER END WITH .187 FQD

MATERIAL:	DRAWN BY: D. HURLBERT	DATE 4-5-80	CINEMATRONICS INC. El Cajon Ca 92020
	PROJECT ENGR:	DATE	DWG TITLE MAIN HARNESS ASSY.
	RELEASE APPROV	DATE	
FINISH:	DO NOT SCALE DWG		MODEL NO. / DWG SIZE C / DWG NO 72-10877-01 / REV
	TOLERANCE: UNLESS OTHERWISE SPECIFIED		
	PROJECTION:	SCALE NONE	CODE IDENT / SHEET 1 OF 2

PROPRIETARY

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED





	J1 CONNECTOR DATA	
PIN NO.	WIRE COLOR	FUNCTION
J1-1	GRN/YEL	CHASSIS GND
J1-2	WHT	TXFMR LUG # 3
△1 J1-3	BLK	TXFMR LUG # 1
J1-4	GRN/YEL	6.3VAC GND
J1-5	ORG	6.3VAC
△2 J1-6	BRN	SPOT KILL (25LINE)
△3 J1-7	YEL	+25V
△4 J1-8	BLU	-25V
J1-9	RED	+5V
J1-10	GRY	+5V
J1-11	BLK	+5V RETURN
J1-12	RED	± 25 V RETURN

△1 3AMP INLINE FUSE.
△2 .5AMP INLINE FUSE.
△3 3AMP INLINE CIRCUIT BREAKER CB 1.
△4 3AMP INLINE CIRCUIT BREAKER CB 2.

	J2 CONNECTOR DATA	
PIN NO.	WIRE COLOR	FUNCTION
J2-1	BRN	TXFMR LUG #1
J2-2	ORG	TXFMR LUG #3
J2-3	RED	TXFMR LUG # 2
J2-4	YEL	TXFMR LUG # 4

POWER SUPPLY CONECTORS
BOTH J1 & J2 AS VIEWED FROM THE FRONT OF POWER SUPPLY.

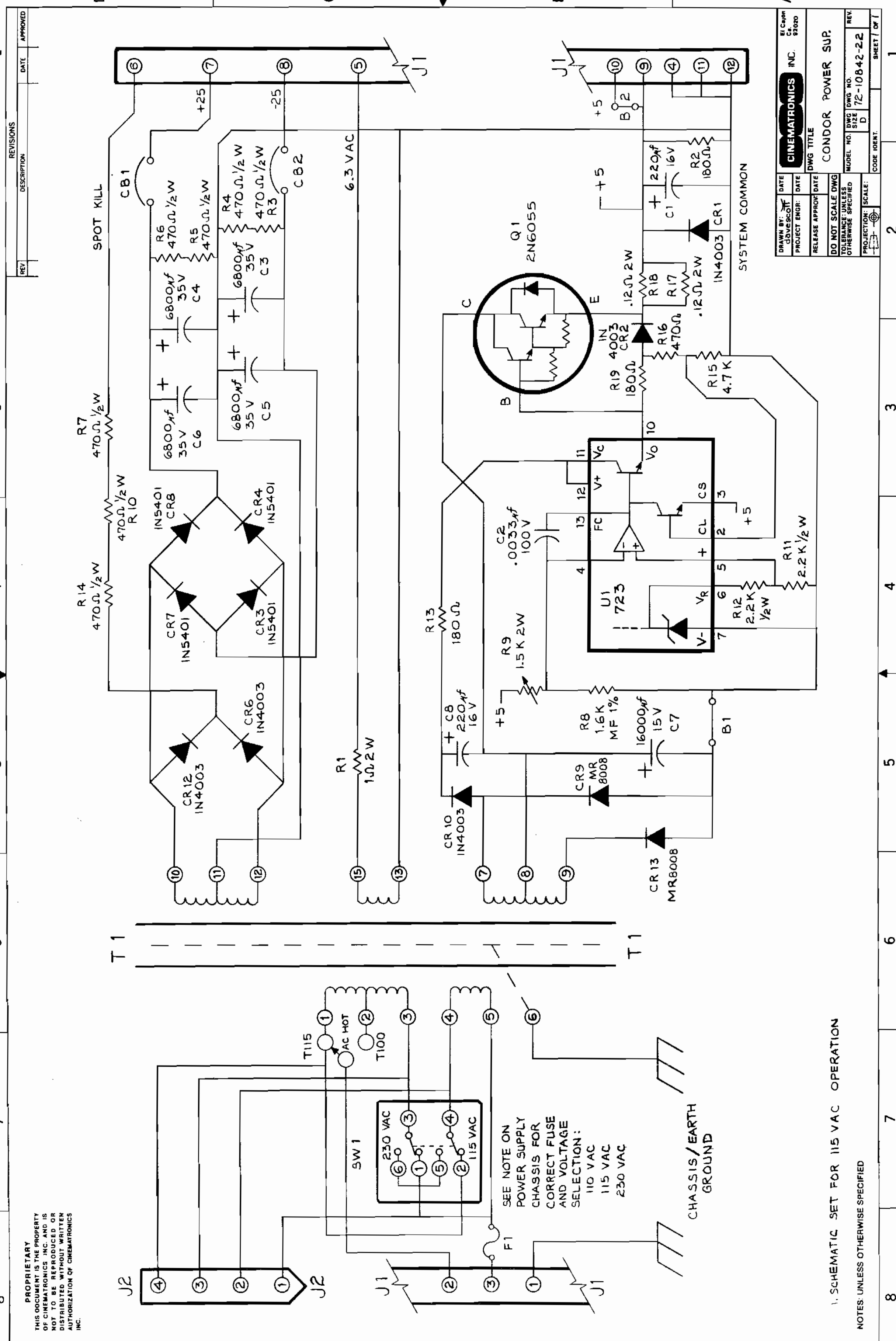
NOTES: UNLESS OTHERWISE SPECIFIED

MATERIAL:
FINISH: BREAK ALL SHARP EDGES AND DEBURR ALL HOLES.

DRAWN BY: A. Macale — DATE 8/2/79
PROJECT ENGR: C. Williams — DATE 9-79
RELEASE APPROV: CEW — DATE 9-79
DO NOT SCALE DWG
TOLERANCE: UNLESS OTHERWISE SPECIFIED
PROJECTION: — SCALE:

CINEMATRONICS INC. El Cajon Ca. 92020
DWG TITLE: POWER SUPPLY PINOUT ILLUSTRATION
MODEL NO. — DWG SIZE C — DWG NO. 72-10877-03 — REV.
CODE IDENT. — SHEET 1 OF 1

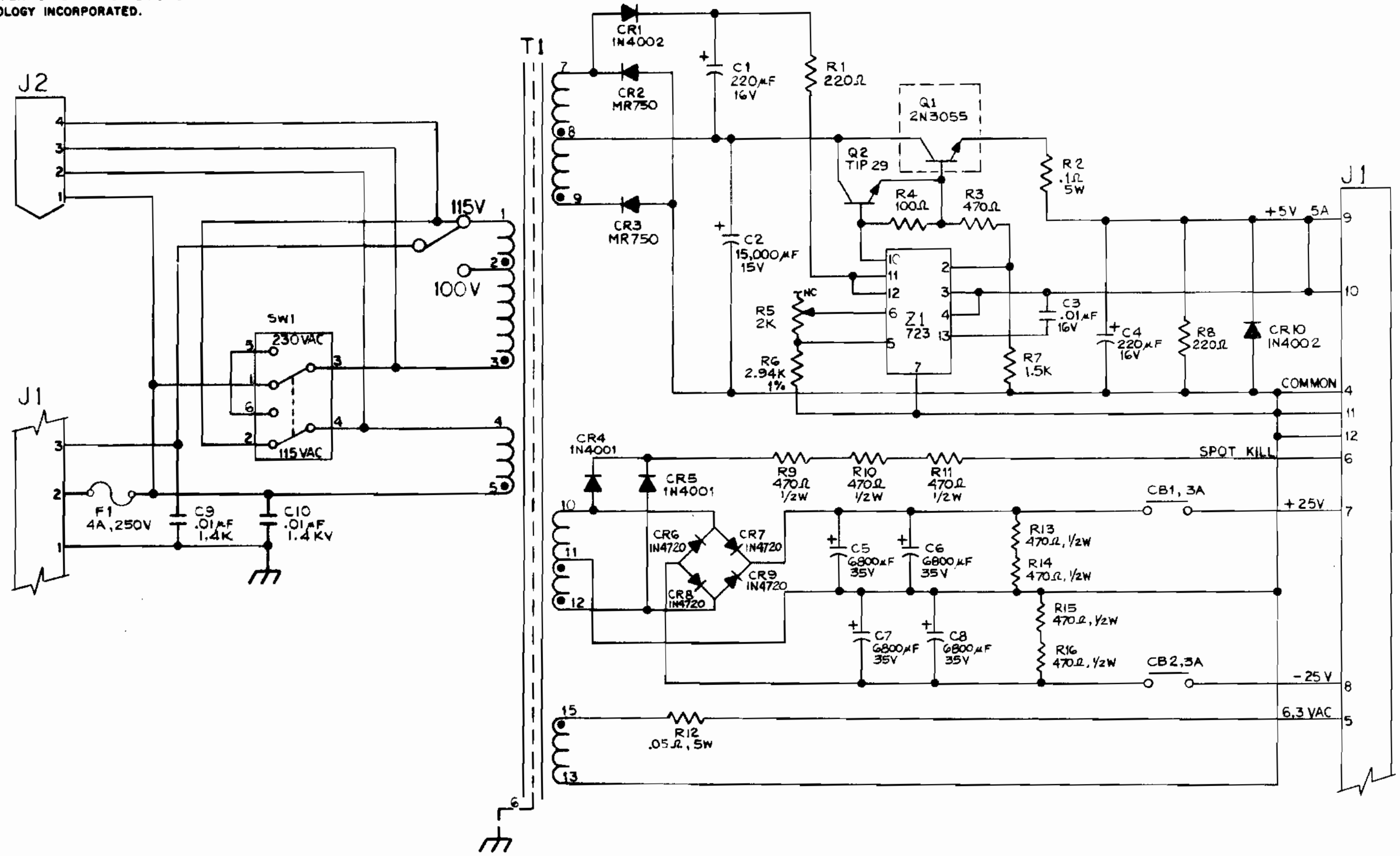
BRUNING 40-21 40423



CINEMATRONICS INC. El Cajon Ca. 92020
DWG TITLE CONDOR POWER SUP.
DWG NO. 72-10842-22
SIZE D
SHEET 1 OF 1
DRAWN BY: dovescott
PROJECT ENGR:
RELEASE APPROVAL
DO NOT SCALE DWG
TOLERANCE UNLESS OTHERWISE SPECIFIED
PROJECTION: SCALE:
CODE IDENT.
REVISIONS
REV DESCRIPTION DATE APPROVED
PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF CINEMATRONICS INC. AND IS NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF CINEMATRONICS INC.
NOTES: UNLESS OTHERWISE SPECIFIED
1. SCHEMATIC SET FOR 115 VAC OPERATION
J1
J2
T1
SW1
230 VAC
115 VAC
T115
T100
AC HOT
F1
SEE NOTE ON POWER SUPPLY CHASSIS FOR CORRECT FUSE AND VOLTAGE SELECTION:
110 VAC
115 VAC
230 VAC
CHASSIS/EARTH GROUND
SPOT KILL
CB1
CB2
+25
-25
6.3 VAC
R6 470Ω ½W
R5 470Ω ½W
R4 470Ω ½W
R3 470Ω ½W
C4 6800µf 35V
C3 6800µf 35V
C6 6800µf 35V
C5 6800µf 35V
R7 470Ω ½W
R10 470Ω ½W
R14 470Ω ½W
CR8 IN5401
CR4 IN5401
CR7 IN5401
CR3 IN5401
CR6 IN4003
CR12 IN4003
R1 1Ω 2W
Q1 2N6055
C B E
CR2 IN4003
R16 470Ω
R18 .12Ω 2W
R17 .12Ω 2W
CR1 IN4003
C1 220µf 16V
R2 180Ω
SYSTEM COMMON
R19 180Ω
R15 4.7K
+5
B2
U1 723
Vc V+ Vo FC CS CL VR V-
C2 .0033µf 100V
R11 2.2K ½W
R12 2.2K ½W
R13 180Ω
R9 1.5K 2W
R8 1.6K MF 1%
C8 220µf 16V
C7 16000µf 15V
B1
CR9 MR8008
CR10 IN4003
CR13 MR8008

PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF NATIONAL POWER TECHNOLOGY, NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF NATIONAL POWER TECHNOLOGY INCORPORATED.

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

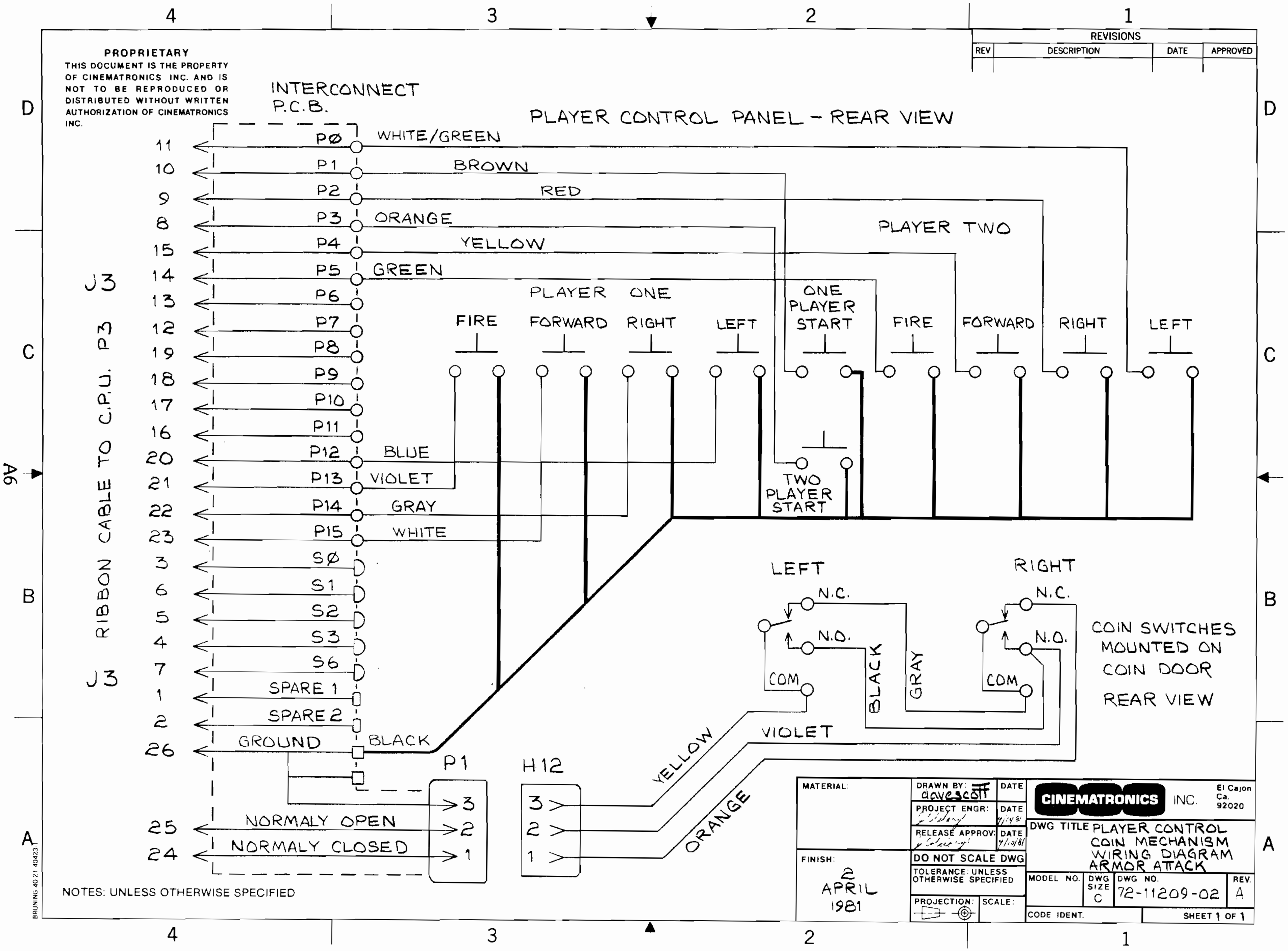


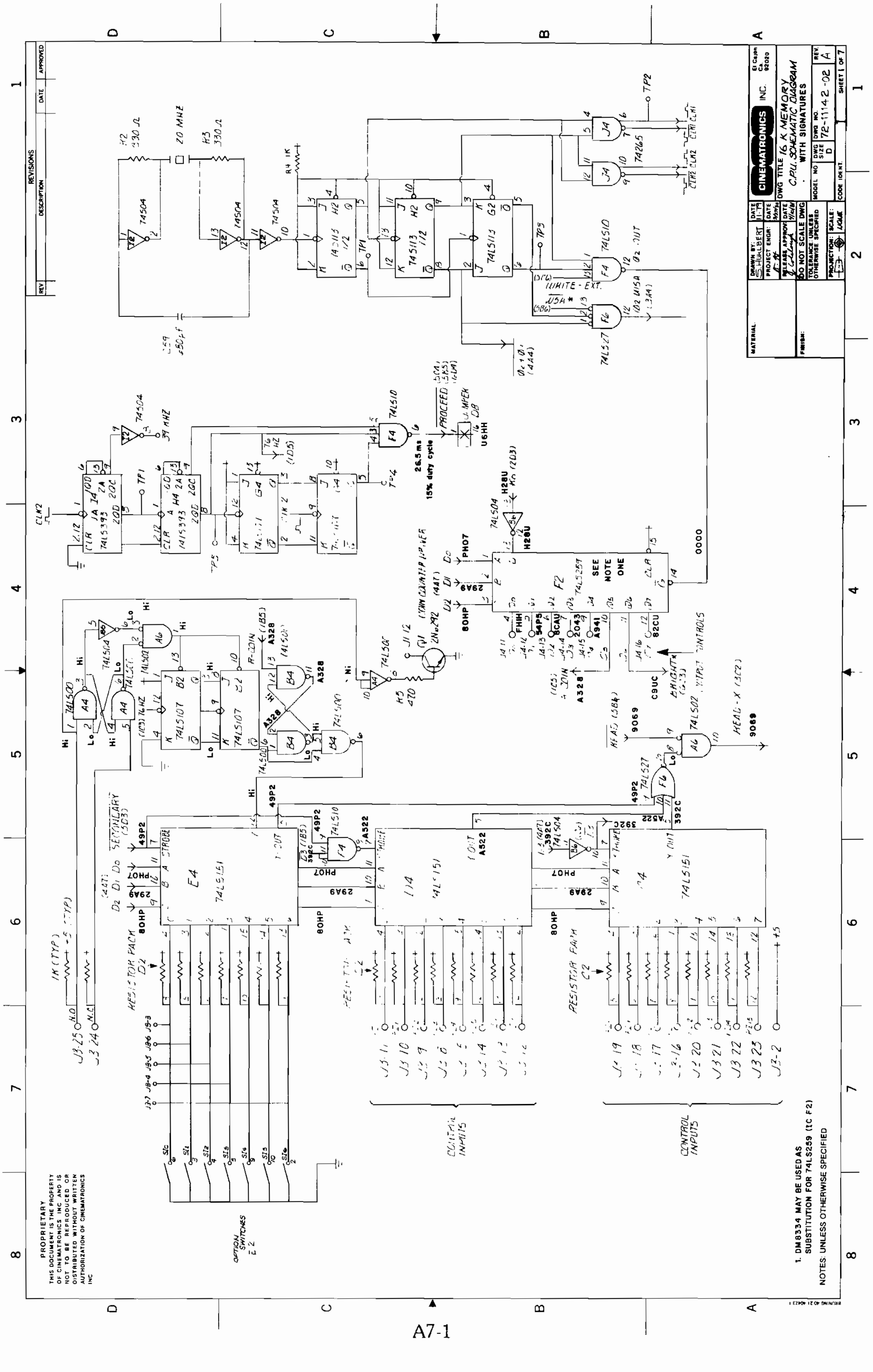
NOTES: UNLESS OTHERWISE SPECIFIED

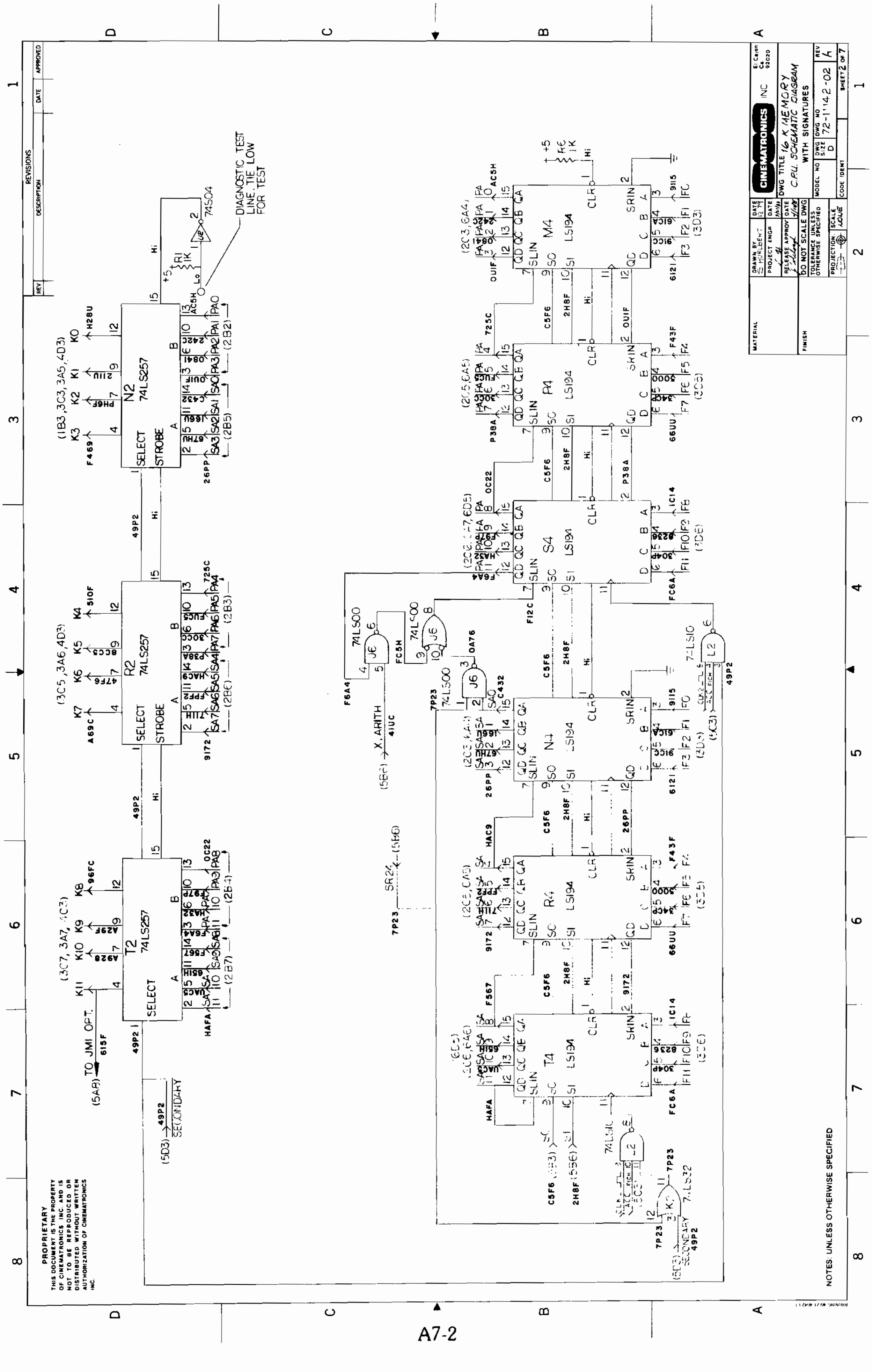
MATERIAL:	DRAWN BY: C. ESCALERAS	DATE	**CINEMATRONICS** INC. El Cajon Ca. 92020
	PROJECT ENGR:	DATE	
	RELEASE APPROV:	DATE	DWG TITLE NATIONAL POWER TECHNOLOGY POWER SUPPLY
FINISH:	DO NOT SCALE DWG		MODEL NO. / DWG SIZE C / DWG NO. 72-10842-42 / REV. A
	TOLERANCE: UNLESS OTHERWISE SPECIFIED		
	PROJECTION:	SCALE:	CODE IDENT. / SHEET 1 OF 1

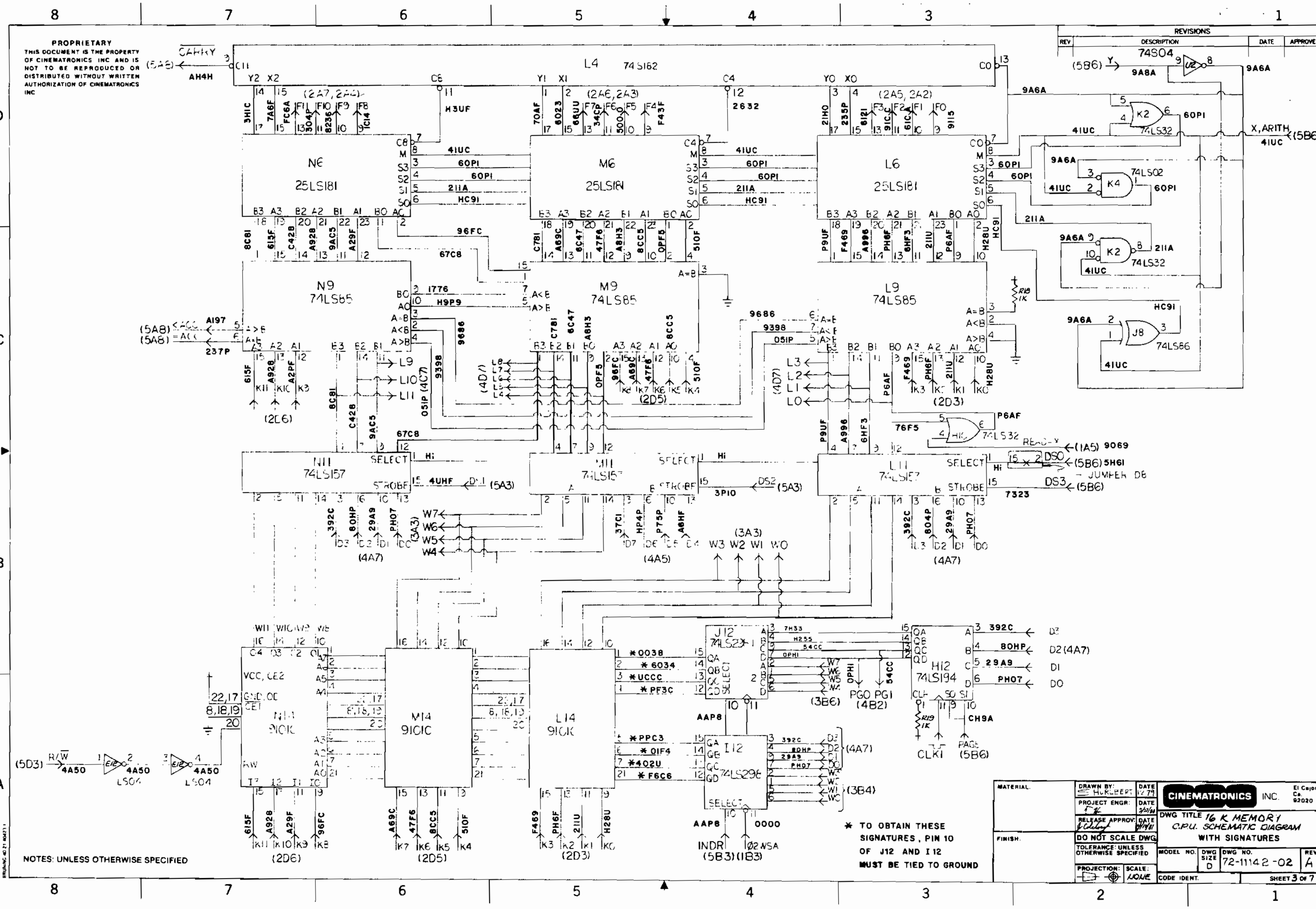
A5

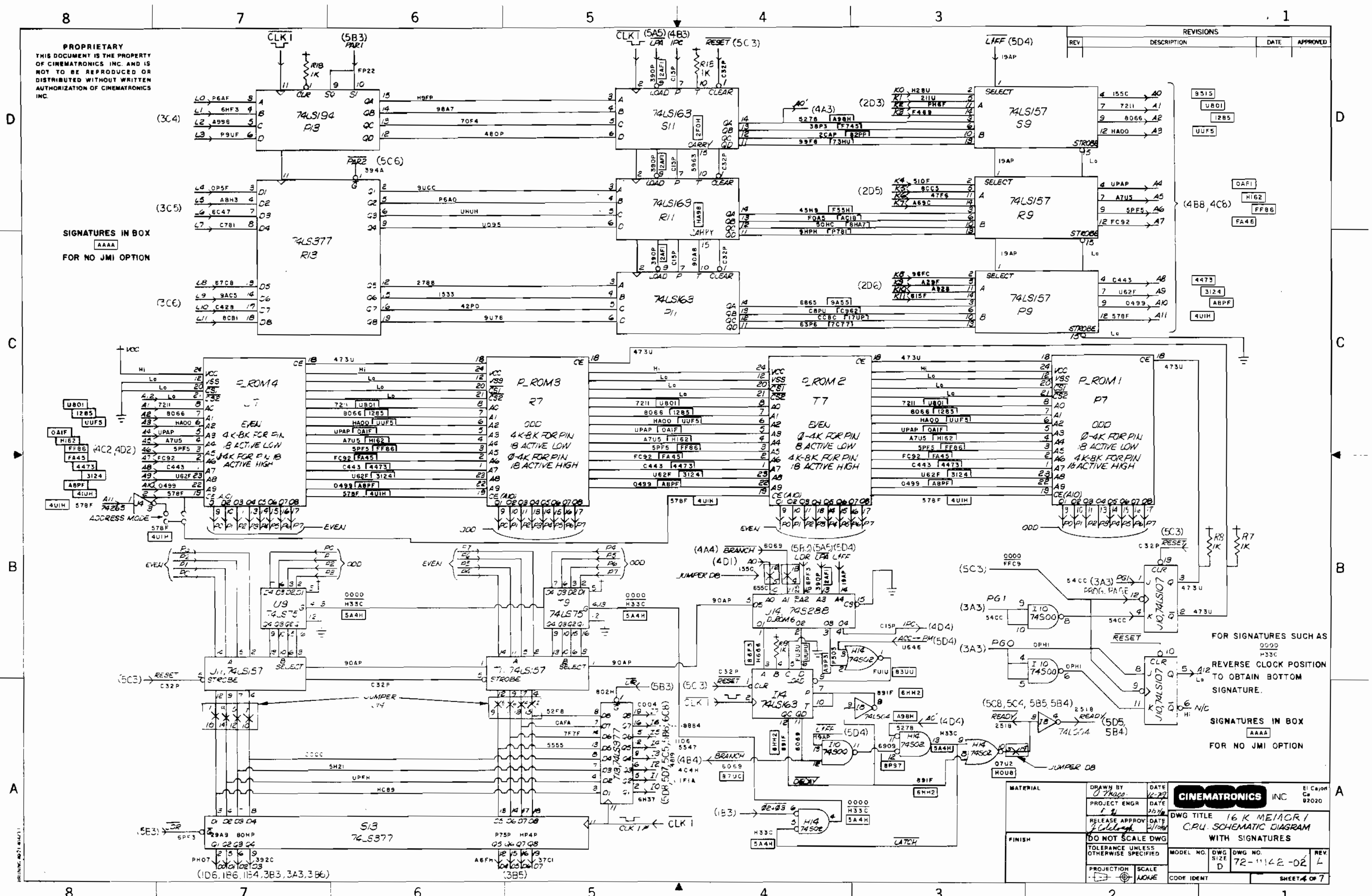
BRUNING 40-21 40423

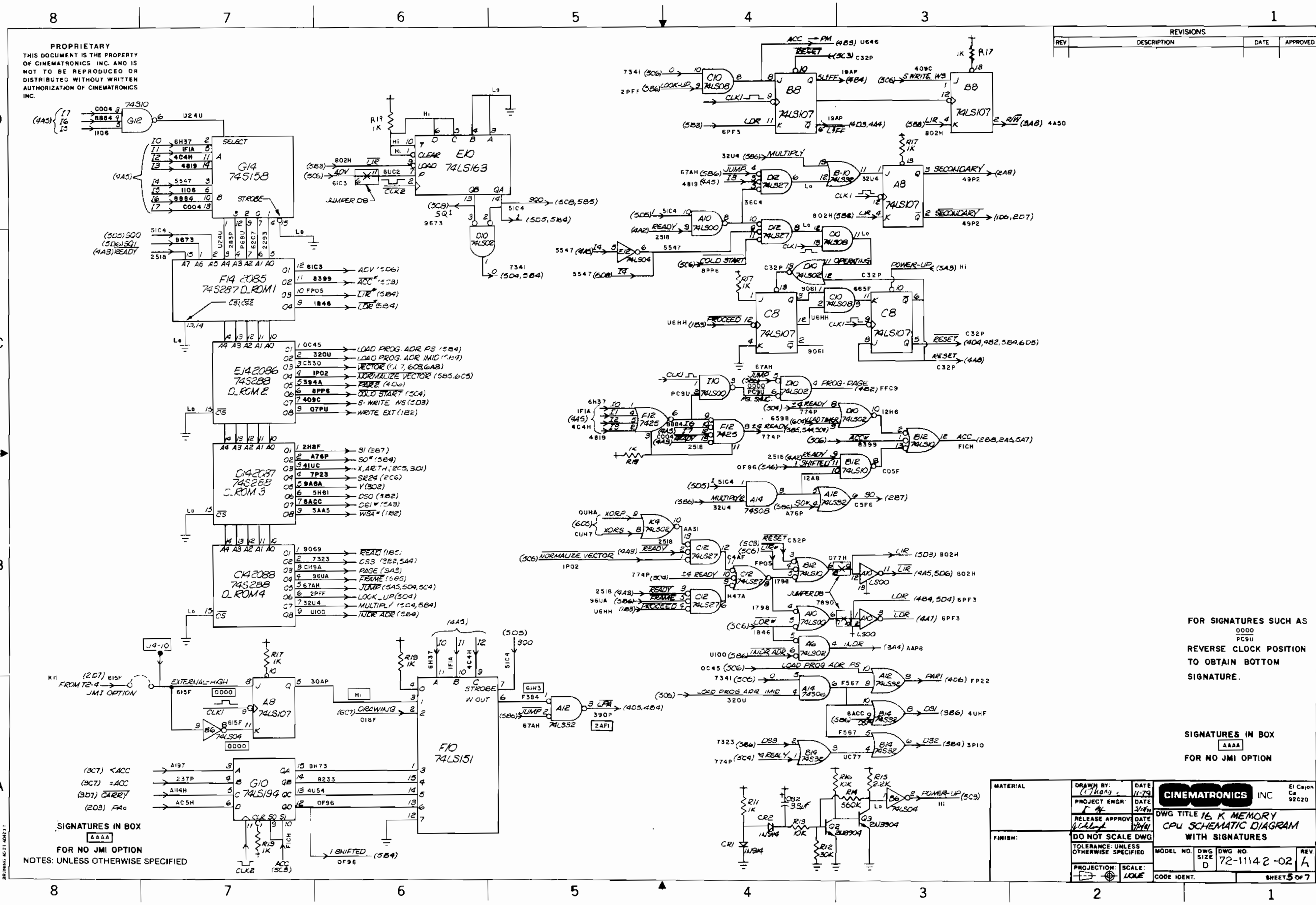

PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF CINEMATRONICS INC. AND IS NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF CINEMATRONICS INC.
REVISIONS
REV
DESCRIPTION
DATE
APPROVED
INTERCONNECT P.C.B.
PLAYER CONTROL PANEL - REAR VIEW
J3 RIBBON CABLE TO C.P.U. P3 J3
11 P0 WHITE/GREEN
10 P1 BROWN
9 P2 RED
8 P3 ORANGE
15 P4 YELLOW
14 P5 GREEN
13 P6
12 P7
19 P8
18 P9
17 P10
16 P11
20 P12 BLUE
21 P13 VIOLET
22 P14 GRAY
23 P15 WHITE
3 S0
6 S1
5 S2
4 S3
7 S6
1 SPARE 1
2 SPARE 2
26 GROUND BLACK
25 NORMALY OPEN
24 NORMALY CLOSED
PLAYER ONE
FIRE
FORWARD
RIGHT
LEFT
ONE PLAYER START
TWO PLAYER START
PLAYER TWO
FIRE
FORWARD
RIGHT
LEFT
LEFT
N.C.
N.O.
COM
RIGHT
N.C.
N.O.
COM
BLACK
GRAY
YELLOW
VIOLET
ORANGE
COIN SWITCHES MOUNTED ON COIN DOOR
REAR VIEW
P1
3
2
1
H12
3
2
1
NOTES: UNLESS OTHERWISE SPECIFIED
MATERIAL:
FINISH:
2 APRIL 1981
DRAWN BY: davescott
DATE
PROJECT ENGR:
DATE
RELEASE APPROV:
DATE
DO NOT SCALE DWG
TOLERANCE: UNLESS OTHERWISE SPECIFIED
PROJECTION:
SCALE:
CINEMATRONICS INC.
El Cajon Ca. 92020
DWG TITLE PLAYER CONTROL COIN MECHANISM WIRING DIAGRAM ARMOR ATTACK
MODEL NO.
DWG SIZE C
DWG NO. 72-11209-02
REV. A
CODE IDENT.
SHEET 1 OF 1
A6


CINEMATRONICS INC.
El Cajon Ca. 92020
DWG TITLE 16 K MEMORY C.P.U. SCHEMATIC DIAGRAM WITH SIGNATURES
DRAWN BY: S. HURLBERT
DO NOT SCALE DWG
TOLERANCE UNLESS OTHERWISE SPECIFIED
SIZE D
DWG NO. 72-1114 2-02
REV. A
SHEET 1 OF 7
REVISIONS
REV
DESCRIPTION
DATE
APPROVED
MATERIAL
FINISH
PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF CINEMATRONICS INC AND IS NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF CINEMATRONICS INC
NOTES: UNLESS OTHERWISE SPECIFIED
1. DM8334 MAY BE USED AS SUBSTITUTION FOR 74LS259 (IC F2)
20 MHZ
74S04
74LS10
74LS27
74S113
74LS393
74LS107
74LS151
74LS259
SEE NOTE ONE
26.5 ms
15% duty cycle
PROCEED
JUMPER
CONTROL INPUTS
OPTION SWITCHES E2
RESISTOR PACK
WHITE - EXT.
TP1
TP2
TP5

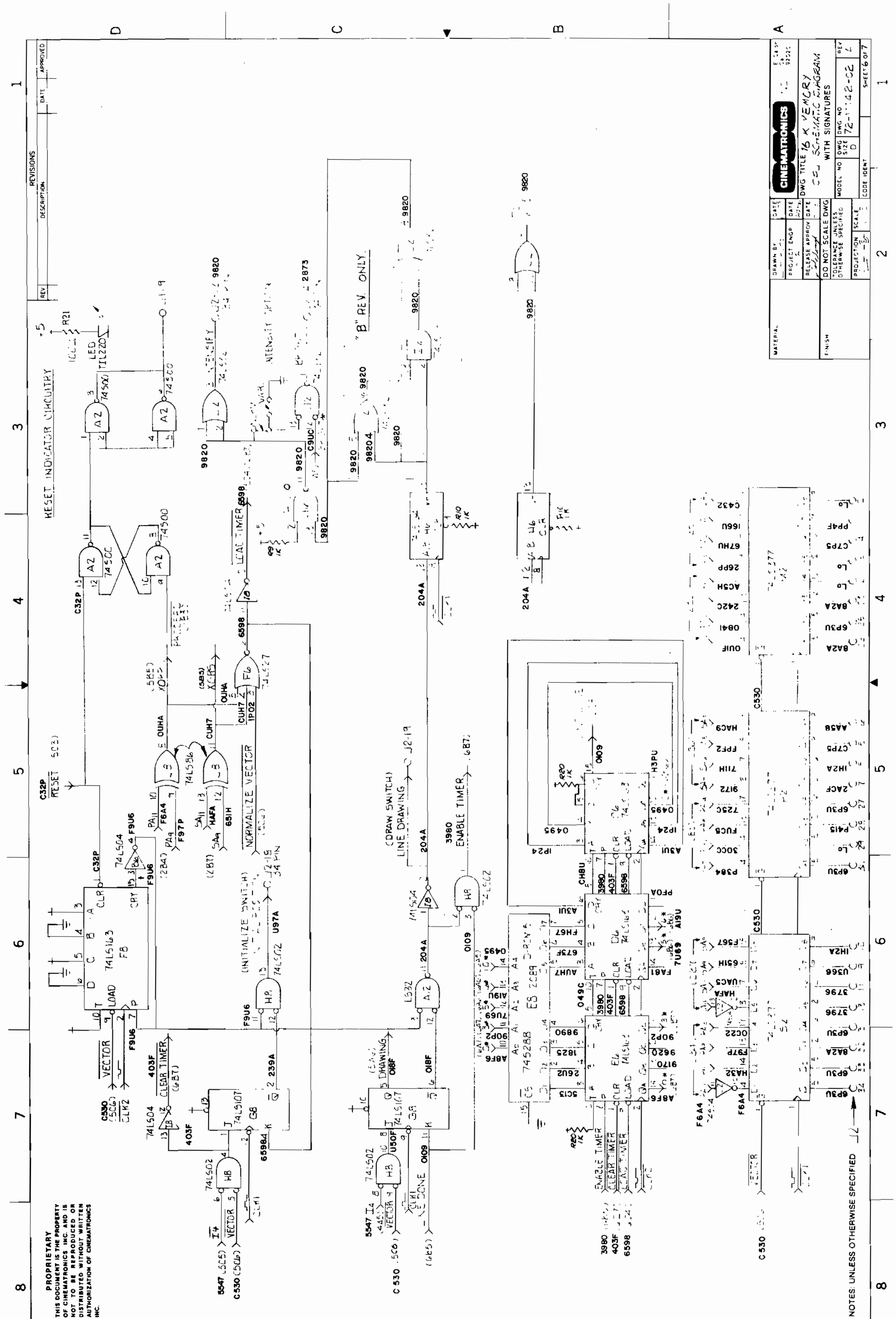

CINEMATRONICS INC
El Cajon Ca 92020
DWG TITLE 16 K MEMORY CPU SCHEMATIC DIAGRAM
WITH SIGNATURES
72-1142-02
SHEET 2 OF 7
REVISIONS
DIAGNOSTIC TEST LINE, TIE LOW FOR TEST
74LS257
LS194
NOTES: UNLESS OTHERWISE SPECIFIED
PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF CINEMATRONICS INC. AND IS NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF CINEMATRONICS INC.


PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF CINEMATRONICS INC AND IS NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF CINEMATRONICS INC
NOTES: UNLESS OTHERWISE SPECIFIED
* TO OBTAIN THESE SIGNATURES, PIN 10 OF J12 AND I12 MUST BE TIED TO GROUND
CINEMATRONICS INC. El Cajon Ca 92020
DWG TITLE 16 K MEMORY C.P.U. SCHEMATIC DIAGRAM WITH SIGNATURES
DWG NO. 72-11142-02
REV. A
SHEET 3 OF 7
DO NOT SCALE DWG
SCALE: NONE


PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF CINEMATRONICS INC. AND IS NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF CINEMATRONICS INC.
SIGNATURES IN BOX AAAA FOR NO JMI OPTION
74LS194 P13
74LS377 R13
74LS163 S11
74LS163 R11
74LS163 P11
74LS157 S9
74LS157 R9
74LS157 P9
P_ROM4 U7 EVEN 4K-8K FOR PIN 18 ACTIVE LOW Ø-4K FOR PIN 18 ACTIVE HIGH
P_ROM3 R7 ODD 4K-8K FOR PIN 18 ACTIVE LOW Ø-4K FOR PIN 18 ACTIVE HIGH
P_ROM2 T7 EVEN Ø-4K FOR PIN 18 ACTIVE LOW 4K-8K FOR PIN 18 ACTIVE HIGH
P_ROM1 P7 ODD Ø-4K FOR PIN 18 ACTIVE LOW 4K-8K FOR PIN 18 ACTIVE HIGH
U9 74LS75
T9 74LS75
J11 74LS157
T11 74LS157
S13 74LS377
T13 74LS377
J14 74S288 D_ROM6
T14 74LS163
J10 74LS107
ADDRESS MODE
JUMPER DB
JUMPER JY
FOR SIGNATURES SUCH AS 0000 H33C REVERSE CLOCK POSITION TO OBTAIN BOTTOM SIGNATURE.
SIGNATURES IN BOX AAAA FOR NO JMI OPTION
REVISIONS
REV DESCRIPTION DATE APPROVED
MATERIAL
FINISH
CINEMATRONICS INC El Cajon Ca 92020
DWG TITLE 16 K METEOR / C.P.U. SCHEMATIC DIAGRAM WITH SIGNATURES
DO NOT SCALE DWG
TOLERANCE UNLESS OTHERWISE SPECIFIED
MODEL NO. DWG SIZE D DWG NO. 72-1142-02 REV. L
PROJECTION SCALE NONE
CODE IDENT SHEET 4 OF 7


PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF CINEMATRONICS INC. AND IS NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF CINEMATRONICS INC.
REVISIONS
REV
DESCRIPTION
DATE
APPROVED
FOR SIGNATURES SUCH AS 0000 PC9U REVERSE CLOCK POSITION TO OBTAIN BOTTOM SIGNATURE.
SIGNATURES IN BOX AAAA FOR NO JMI OPTION
SIGNATURES IN BOX AAAA FOR NO JMI OPTION
NOTES: UNLESS OTHERWISE SPECIFIED
CINEMATRONICS INC
El Cajon Ca 92020
DWG TITLE 16 K MEMORY CPU SCHEMATIC DIAGRAM WITH SIGNATURES
DWG SIZE D
DWG NO. 72-1114 2 -02
SHEET 5 OF 7
DO NOT SCALE DWG
TOLERANCE: UNLESS OTHERWISE SPECIFIED
MATERIAL
FINISH
G14 74S158
F14 2085 74S287 D_ROM1
E14 2086 74S288 D_ROM2
C14 2087 74S288 D_ROM3
C14 2088 74S288 D_ROM4
E10 74LS163
G10 74LS194
F10 74LS151
A8 74LS107
B8 74LS107
C8 74LS107
FROM T2-4 JMI OPTION

A7-5



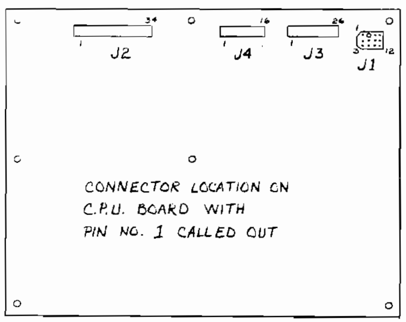
REVISIONS
REV
DESCRIPTION
DATE
APPROVED
RESET INDICATOR CIRCUITRY
LED TIL220
NORMALIZE VECTOR
(INITIALIZE SWITCH)
(DRAW SWITCH) LINE DRAWING
ENABLE TIMER
"B" REV. ONLY
CLEAR TIMER
74LS163
74LS107
74LS02
74LS04
74LS86
74S288
PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF CINEMATRONICS INC. AND IS NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF CINEMATRONICS INC.
NOTES: UNLESS OTHERWISE SPECIFIED
CINEMATRONICS
16 K MEMORY
CPU SCHEMATIC DIAGRAM
WITH SIGNATURES
DO NOT SCALE DWG

REVISIONS

REV	DESCRIPTION	DATE	APPROVED

CONNECTOR J1

PIN NO.	FUNCTION	FROM/TO IC-PIN NO.	SCHMTC LOCATION SHT-AREA
1	NC		
2	NC		
3	COIN COUNTER	FROM COLLECTOR OF Q1	1-C4
4 (FEMALE)	GND		
5	GND		
6	GND		
7	NC		
8	NC		
9	LED CATHODE	FROM A2-3,6	6-D3
10	+5		
11	+5		
12	NC		



CONNECTOR J2

PIN NO.	FUNCTION	FROM/TO IC-PIN NO.	SCHMTC LOCATION SHT-AREA
1	YDAC BIT 1	FROM M2-9	6-A4
2	YDAC BIT Ø	FROM M2-19	
3	YDAC BIT 3	FROM M2-2	
4	YDAC BIT 2	FROM M2-6	
5	YDAC BIT 5	FROM P2-9	6-A5
6	YDAC BIT 4	FROM P2-19	
7	YDAC BIT 7	FROM P2-2	
8	YDAC BIT 6	FROM P2-6	
9	YDAC BIT 9	FROM S2-9	6-A6
10	YDAC BIT 8	FROM S2-19	
11	YDAC BIT 1Ø	FROM S2-6	
12	INTENSITY	FROM J2-3	6-D3
13	YDAC BIT 11	FROM S2-2	6-A6
14	BRIGHT	FROM J2-11	6-C3
15	GND		
16	XDAC OUTPUT	FROM DISPLAY PCB TO CONN. J4-4	
17	GND		
18	INITIALIZE SWITCH	FROM H8-13	6-C6
19	DRAW SWITCH	FROM I8-2	6-C5
20	GND		
21	XDAC BIT Ø	FROM M2-16	6-A4
22	GND		
23	XDAC BIT 1	FROM M2-12	
24	GND		
25	XDAC BIT 2	FROM M2-15	
26	XDAC BIT 3	FROM M2-5	
27	XDAC BIT 4	FROM P2-16	6-A5
28	XDAC BIT 5	FROM P2-12	
29	XDAC BIT 6	FROM P2-15	
30	XDAC BIT 7	FROM P2-5	
31	XDAC BIT 8	FROM S2-16	6-A6
32	XDAC BIT 9	FROM S2-12	
33	XDAC BIT 1Ø	FROM S2-15	
34	XDAC BIT 11	FROM S2-5	

CONNECTOR J3

PIN NO.	FUNCTION	FROM/TO IC-PIN NO.	SCHMTC LOCATION SHT-AREA
1	NC		
2	+5		
3	SECONDARY INPUT Ø	TO E4-4	1-C6
4	SECONDARY INPUT 3	TO E4-1	
5	SECONDARY INPUT 2	TO E4-2	
6	SECONDARY INPUT 1	TO E4-3	
7	SECONDARY INPUT 6	TO E4-13	
8	PRIMARY INPUT 3	TO D4-1	1-B6
9	PRIMARY INPUT 2	TO D4-2	
10	PRIMARY INPUT 1	TO D4-3	
11	PRIMARY INPUT Ø	TO D4-4	
12	PRIMARY INPUT 7	TO D4-12	
13	PRIMARY INPUT 6	TO D4-13	
14	PRIMARY INPUT 5	TO D4-14	
15	PRIMARY INPUT 4	TO D4-15	
16	PRIMARY INPUT 11	TO C4-1	1-A6
17	PRIMARY INPUT 1Ø	TO C4-2	
18	PRIMARY INPUT 9	TO C4-3	
19	PRIMARY INPUT 8	TO C4-4	
20	PRIMARY INPUT 12	TO C4-15 CONN. J4-3	
21	PRIMARY INPUT 13	TO C4-14 CONN. J4-1	
22	PRIMARY INPUT 14	TO C4-13 CONN J4-5	
23	PRIMARY INPUT 15	TO C4-12 CONN. J4-2	
24	COIN SWITCH (NORMALY CLOSED)	TO A4-5	1-D5
25	COIN SWITCH (NORMALY OPEN)	TO A4-1	
26	GND		

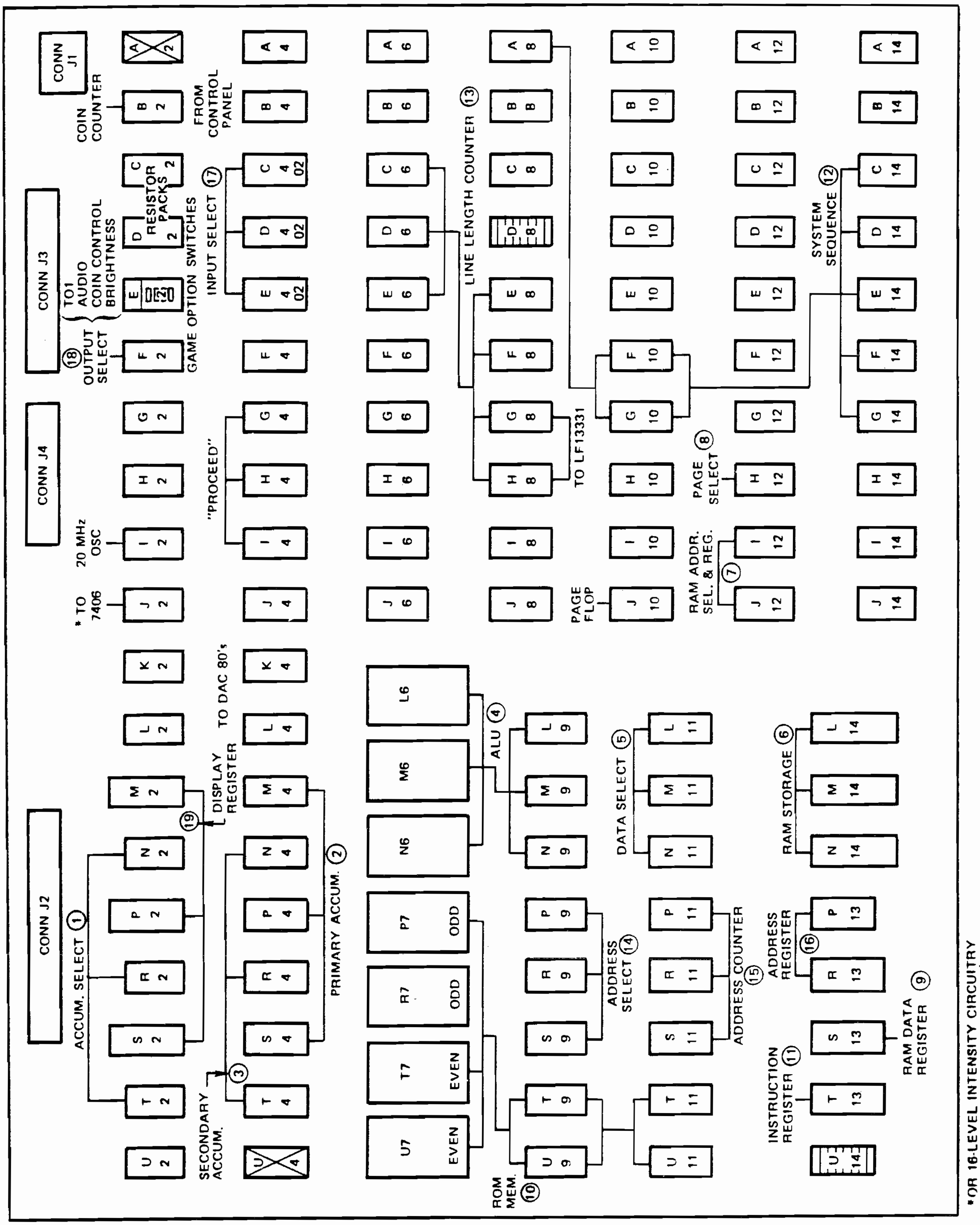
CONNECTOR J4

PIN NO.	FUNCTION	FROM/TO IC-PIN NO.	SCHMTC LOCATION SHT-AREA
1	PRIMARY INPUT 13	TO C4-14 CONN. J3-21	1-A6
2	PRIMARY INPUT 15	TO C4-12 CONN. J3-23	
3	PRIMARY INPUT 12	TO C4-15 CONN. J3-20	
4	XDAC OUTPUT	FROM DISPLAY PCB TO CONN. J2-16	
5	PRIMARY INPUT 14	TO C4-13 CONN. J3-22	1-A6
6	NC		
7	NC		
8	GND		
9	NC		
10	EXTERNAL HIGH OUTPUT	TO A8-8 B6-9	5-A7
11	OUTPUT Ø	FROM F2-4	1-B4
12	OUTPUT 1	FROM F2-5	
13	OUTPUT 2	FROM F2-6	
14	OUTPUT 3	FROM F2-7	
15	OUTPUT 4	FROM F2-9	
16	OUTPUT 7	FROM F2-12	

NOTES: UNLESS OTHERWISE SPECIFIED

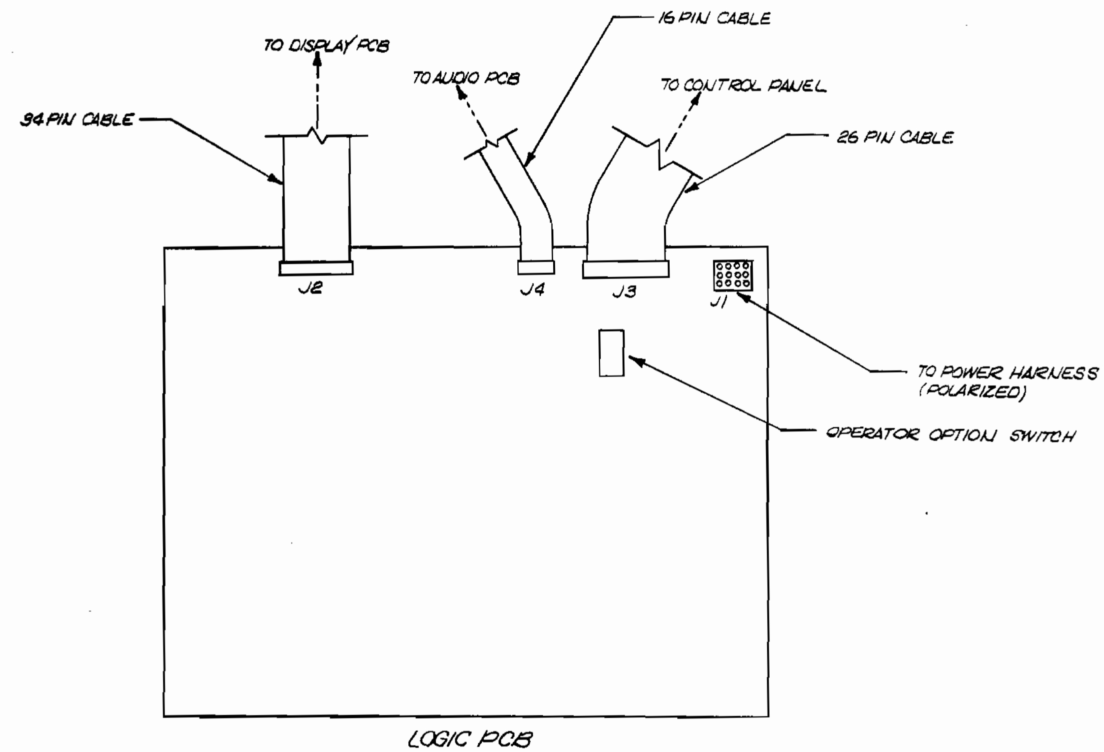
4 JUNE 1980

MATERIAL:	DRAWN BY: davescott	DATE	CINEMATRONICS INC. El Cajon Ca. 92020
	PROJECT ENGR:	DATE	DWG TITLE 16 K MEMORY C.P.U. SCHEMATIC
FINISH:	RELEASE APPROV:	DATE	
	DO NOT SCALE DWG		
	TOLERANCE: UNLESS OTHERWISE SPECIFIED		MODEL NO. / DWG SIZE D / DWG NO. 72-11142-02 / REV. A
	PROJECTION:	SCALE:	CODE IDENT. / SHEET 7 OF 7


CONN J1
CONN J2
CONN J3
CONN J4
COIN COUNTER
RESISTOR PACKS
FROM CONTROL PANEL
INPUT SELECT 17
GAME OPTION SWITCHES
TO1 AUDIO COIN CONTROL BRIGHTNESS
18 OUTPUT SELECT
"PROCEED"
20 MHz OSC
* TO 7406
TO DAC 80's
19 DISPLAY REGISTER
ACCUM. SELECT 1
PRIMARY ACCUM. 2
SECONDARY ACCUM. 3
ALU 4
DATA SELECT 5
RAM STORAGE 6
RAM ADDR. SEL. & REG. 7
PAGE SELECT 8
RAM DATA REGISTER 9
ROM MEM. 10
INSTRUCTION REGISTER 11
SYSTEM SEQUENCE 12
LINE LENGTH COUNTER 13
ADDRESS SELECT 14
ADDRESS COUNTER 15
ADDRESS REGISTER 16
PAGE FLOP
TO LF13331
L6
M6
N6
P7 ODD
R7 ODD
T7 EVEN
U7 EVEN
*OR 16-LEVEL INTENSITY CIRCUITRY

PROPRIETARY

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED



NOTES: UNLESS OTHERWISE SPECIFIED

MATERIAL:	DRAWN BY: A. Thacar	DATE 9-21-79
	PROJECT ENGR: C. William	DATE 9-79
FINISH: BREAK ALL SHARP EDGES AND DEBURR ALL HOLES.	RELEASE APPROV: CEW	DATE 9-79
	DO NOT SCALE DWG	
	TOLERANCE: UNLESS OTHERWISE SPECIFIED	
	PROJECTION:	SCALE:

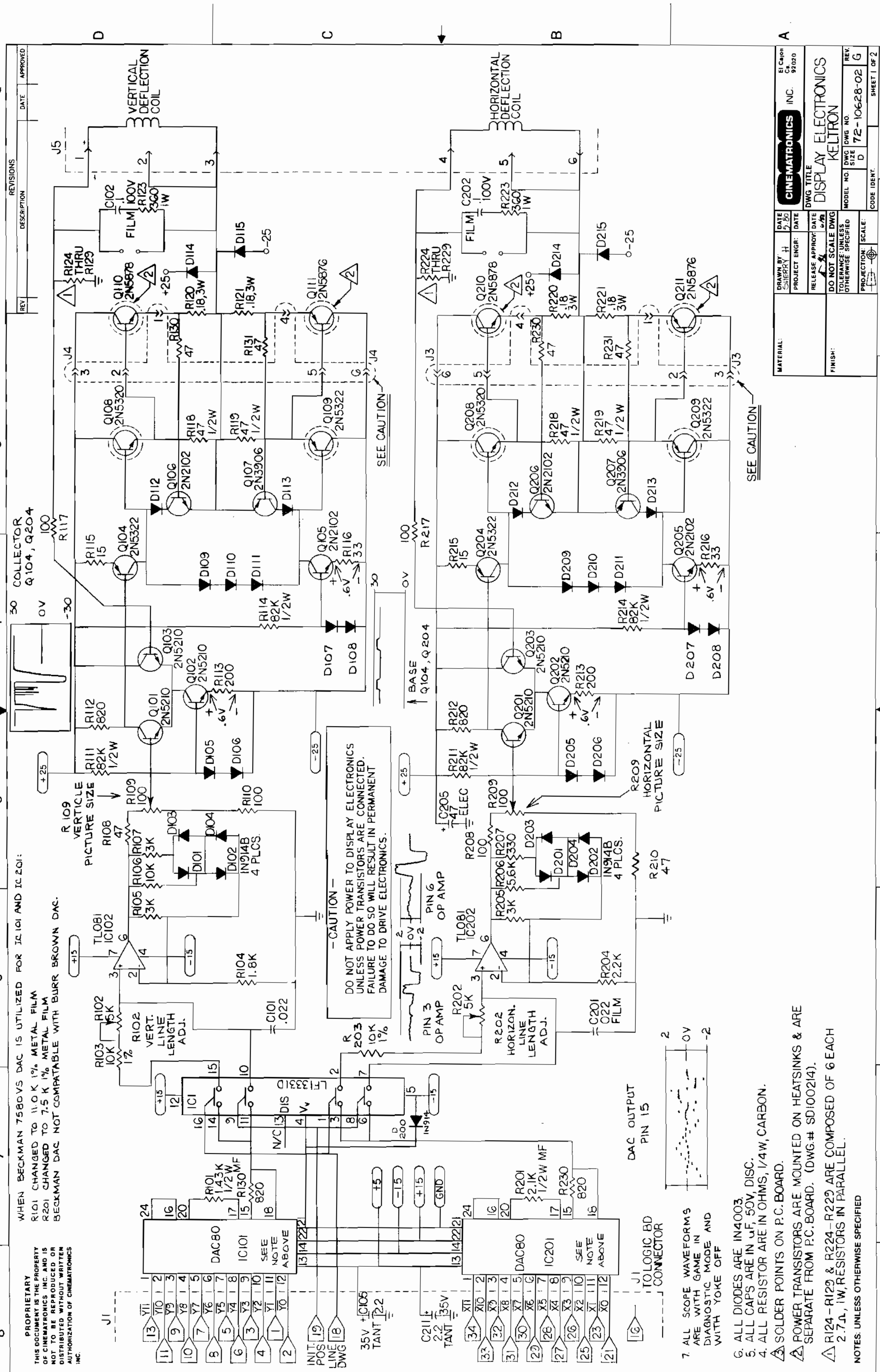
CINEMATRONICS INC. El Cajon Ca. 92020

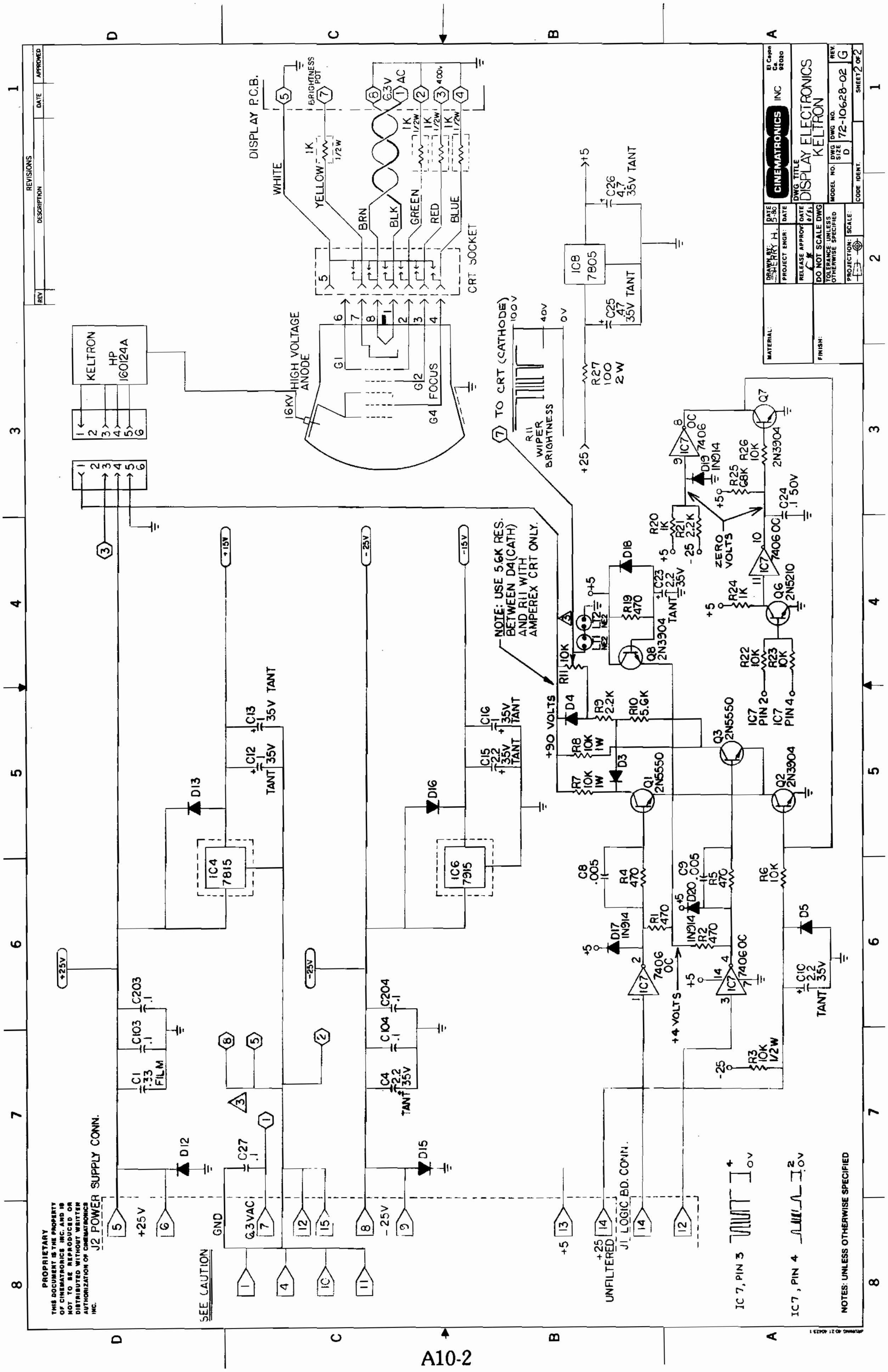
DWG TITLE: C.P.U. BOARD ILLUSTRATION

MODEL NO.	DWG SIZE	DWG NO.	REV.
	C	72-10626-01	

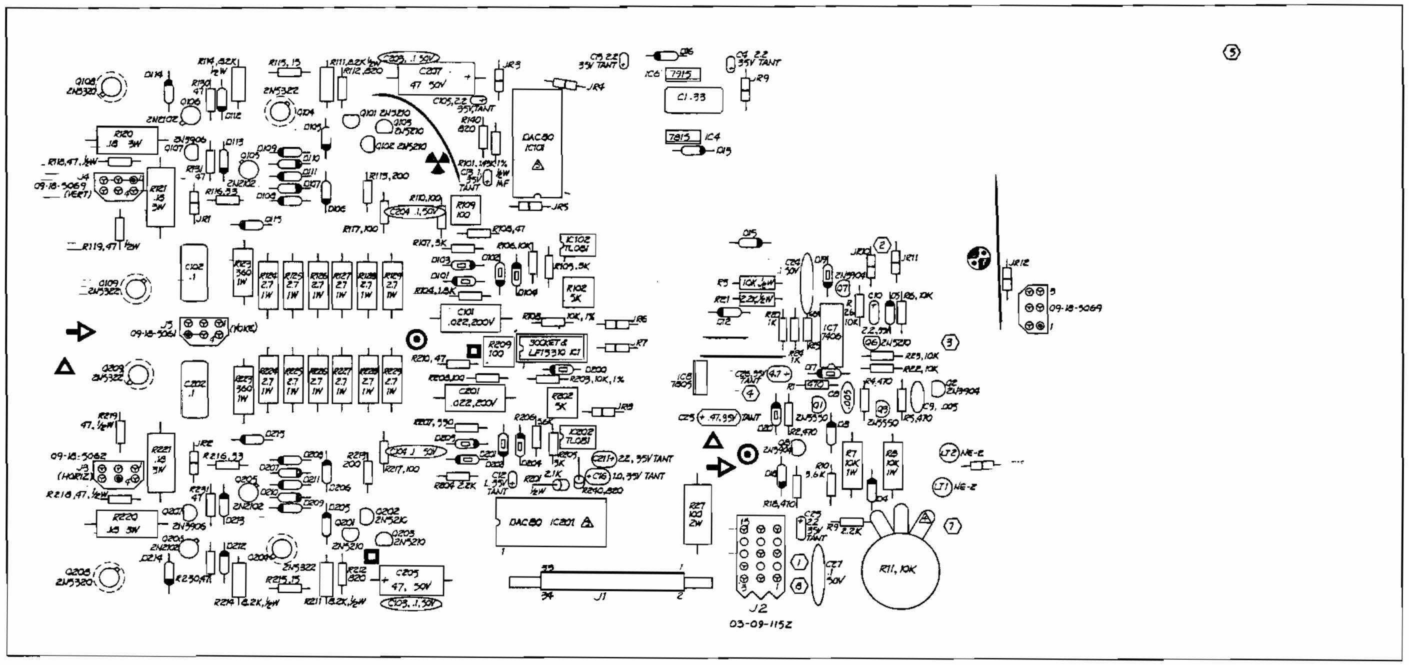
CODE IDENT. SHEET / OF /

BRUNING 40-21 40423


CINEMATRONICS INC. El Cajon Ca. 92020
DWG TITLE DISPLAY ELECTRONICS KELTRON
DWG NO. 72-10628-02
REV. G
SHEET 1 OF 2
PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF CINEMATRONICS INC. AND IS NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF CINEMATRONICS INC.
WHEN BECKMAN 7580VS DAC IS UTILIZED FOR IC101 AND IC201:
R101 CHANGED TO 11.0 K 1% METAL FILM
R201 CHANGED TO 7.5 K 1% METAL FILM
BECKMAN DAC NOT COMPATABLE WITH BURR BROWN DAC.
VERTICAL DEFLECTION COIL
HORIZONTAL DEFLECTION COIL
COLLECTOR Q104, Q204
BASE Q104, Q204
R109 VERTICLE PICTURE SIZE
R209 HORIZONTAL PICTURE SIZE
R102 VERT. LINE LENGTH ADJ.
R202 HORIZON. LINE LENGTH ADJ.
PIN 6 OP AMP
PIN 3 OP AMP
DAC OUTPUT PIN 15
- CAUTION -
DO NOT APPLY POWER TO DISPLAY ELECTRONICS UNLESS POWER TRANSISTORS ARE CONNECTED. FAILURE TO DO SO WILL RESULT IN PERMANENT DAMAGE TO DRIVE ELECTRONICS.
SEE CAUTION
J1 TO LOGIC BD CONNECTOR
NOTES: UNLESS OTHERWISE SPECIFIED
7. ALL SCOPE WAVEFORMS ARE WITH GAME IN DIAGNOSTIC MODE AND WITH YOKE OFF
6. ALL DIODES ARE IN4003.
5. ALL CAPS ARE IN uF, 50V, DISC.
4. ALL RESISTOR ARE IN OHMS, 1/4W, CARBON.
3. SOLDER POINTS ON P.C. BOARD.
2. POWER TRANSISTORS ARE MOUNTED ON HEATSINKS & ARE SEPARATE FROM P.C. BOARD. (DWG.# SD100214).
1. R124-R129 & R224-R229 ARE COMPOSED OF 6 EACH 2.7Ω, 1W, RESISTORS IN PARALLEL.


CINEMATRONICS INC
El Cajon Ca. 92020
DWG TITLE
DISPLAY ELECTRONICS KELTRON
DWG NO. 72-10628-02
SIZE D
REV. G
SHEET 2 OF 2
DO NOT SCALE DWG
PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF CINEMATRONICS INC. AND IS NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF CINEMATRONICS INC.
J2 POWER SUPPLY CONN.
J1 LOGIC BD. CONN.
SEE CAUTION
DISPLAY P.C.B.
CRT SOCKET
HIGH VOLTAGE ANODE
KELTRON HP 160124A
TO CRT (CATHODE)
R11 WIPER BRIGHTNESS
NOTE: USE 5.6K RES. BETWEEN D4(CATH) AND R11 WITH AMPEREX CRT ONLY.
ZERO VOLTS
+90 VOLTS
+4 VOLTS
IC 7, PIN 3
IC 7, PIN 4
NOTES: UNLESS OTHERWISE SPECIFIED

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	K	REDRAWN 4-13-81 WITH NO CHANGE		



REQUIRED JUMPERS			
SYM	SIZE/TYPE	COLOR	QTY
☢	22AWG	BRN	2"
□	22AWG	BRN	3 1/4"
⊙	18AWG	BLK	4 3/4"
△	18AWG	RED	9"
⇨	18AWG	BLU	9"

CRT SOCKET CONNECTIONS			
SYM.	SIZE/TYPE	COLOR	LENGTH
1	18AWG	BLK	10 1/4"
2	18AWG	GRN	13"
3	18AWG	RED	12"
4	18AWG	BLU	11 1/2"
5	18AWG	WHT	15"
7	18AWG	YEL	10"
8	18AWG	BRN	10 1/4"

TWIST BRN & BLK WIRES TOGETHER

NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL CAP. VALUES ARE IN µF.
2. ALL RES. VALUES ARE IN OHMS 1/4 W. 5%, CARBON.
3. DIODES MARKED ARE IN914. ALL OTHERS ARE 1N4009.
4. INSTALL 3.9K, 1/4W RES. ON CIRCUIT SIDE OF BOARD WHEN AMPEREX CRT IS INSTALLED.
5. WHEN BECKMAN 7580 VS DAC IS UTILIZED FOR IC101 & IC201:
   R101 CHANGE TO 7.5K 1% METAL FILM.
   R201 CHANGE TO 11.0K 1% METAL FILM.
   (BECKMAN DAC NOT COMPATABLE WITH BURR BROWN DAC)
6. JR = JUMPER RES. (ZERO OHM).

INTERPRET DRAWING IN ACCORDANCE WITH MIL-D-1000, LEVEL

MATERIAL	DRAWN BY S. KULOUKO	CINEMATRONICS INC.	
	PROJECT ENGR	DWG TITLE DISPLAY P.C.B. ASSY. (KELTRON)	
FINISH	RELEASE APPROV.		
	DO NOT SCALE DWG		
	TOLERANCE UNLESS OTHERWISE SPECIFIED	DWG NO 72-10628-01	REV K
	PROJECTION / SCALE NONE	CODE IDENT	SHEET 1 OF 1

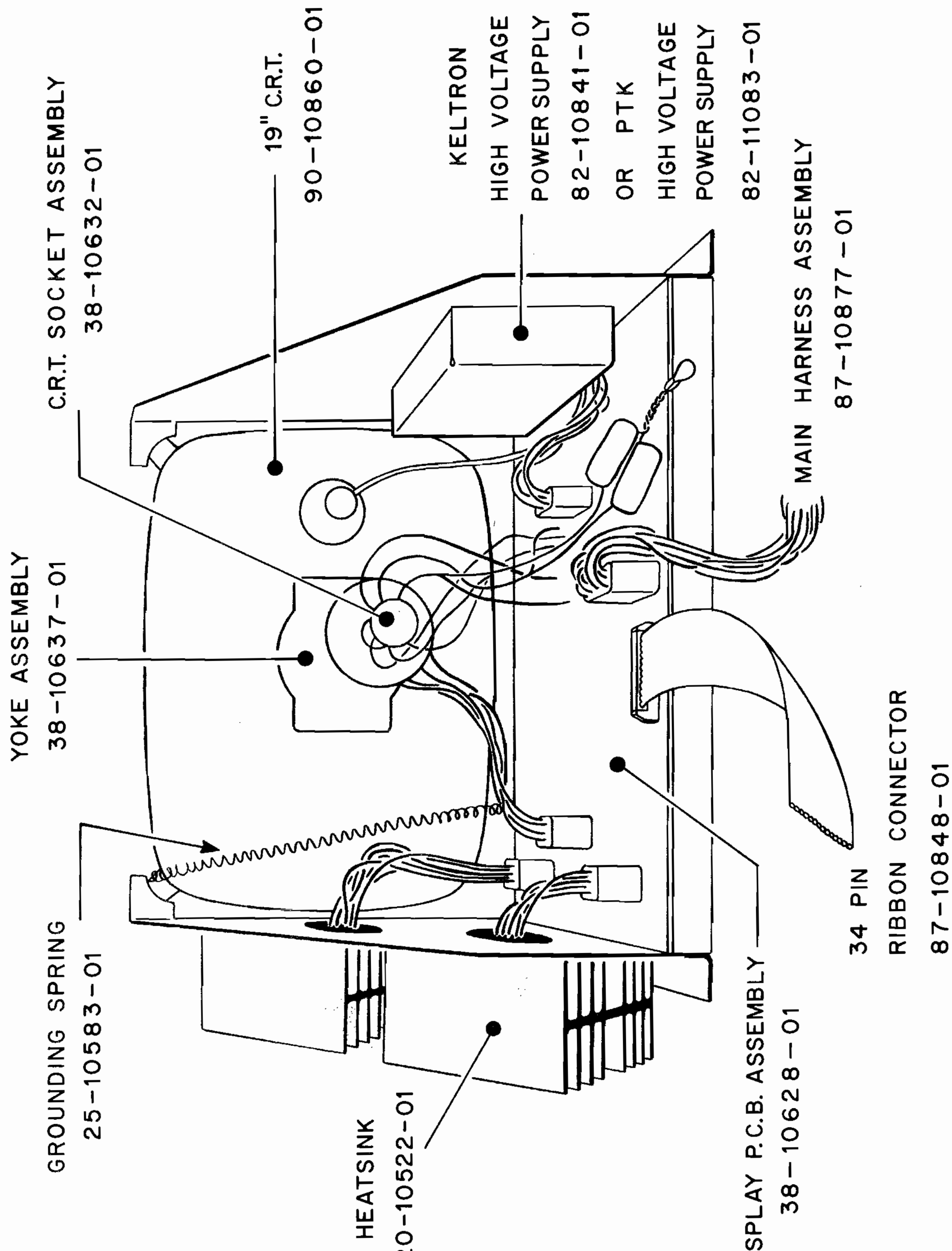
CONTROL

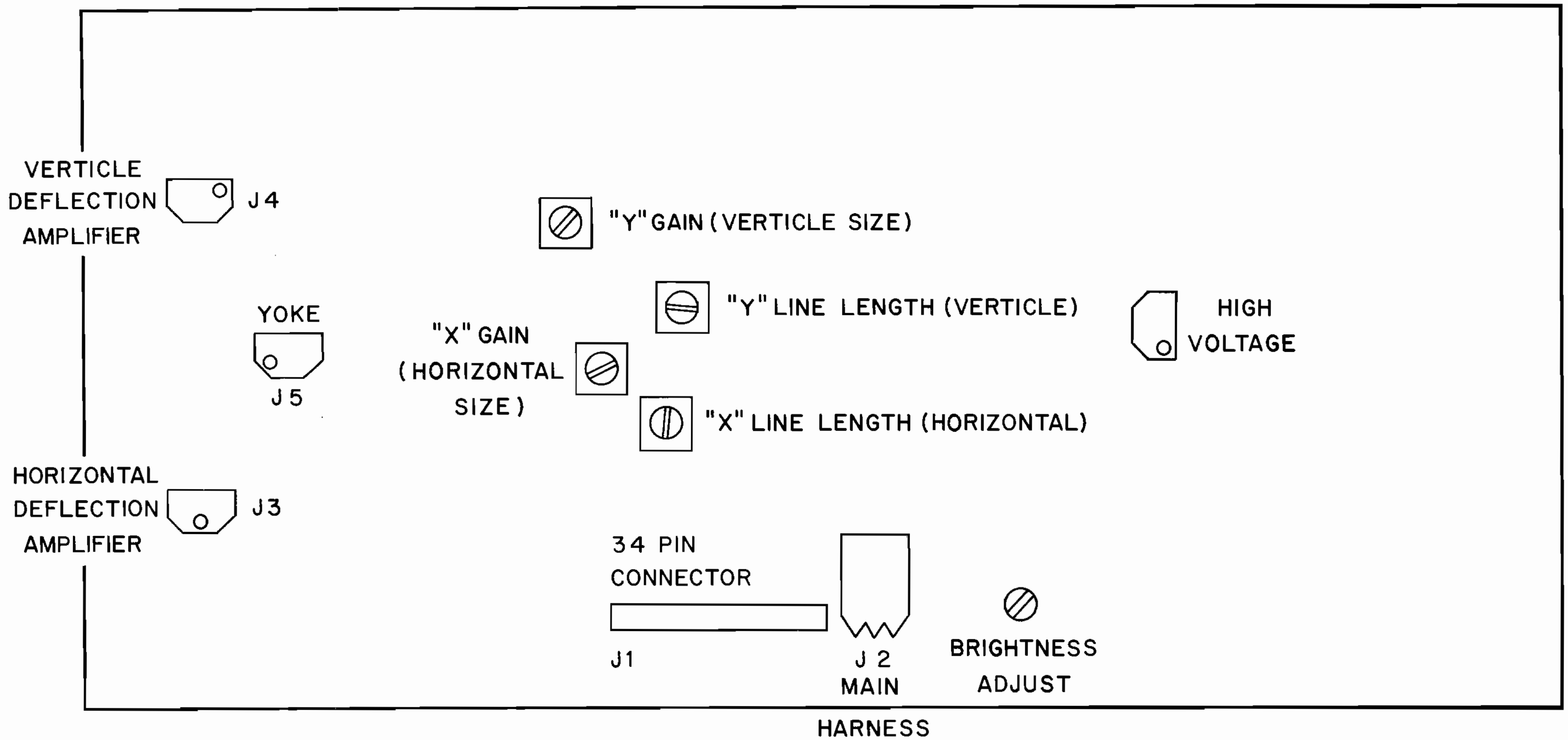
MONITOR ASSEMBLY (KELTRON)

38–10633–01

MONITOR ASSEMBLY (PTK)

38–11207–01

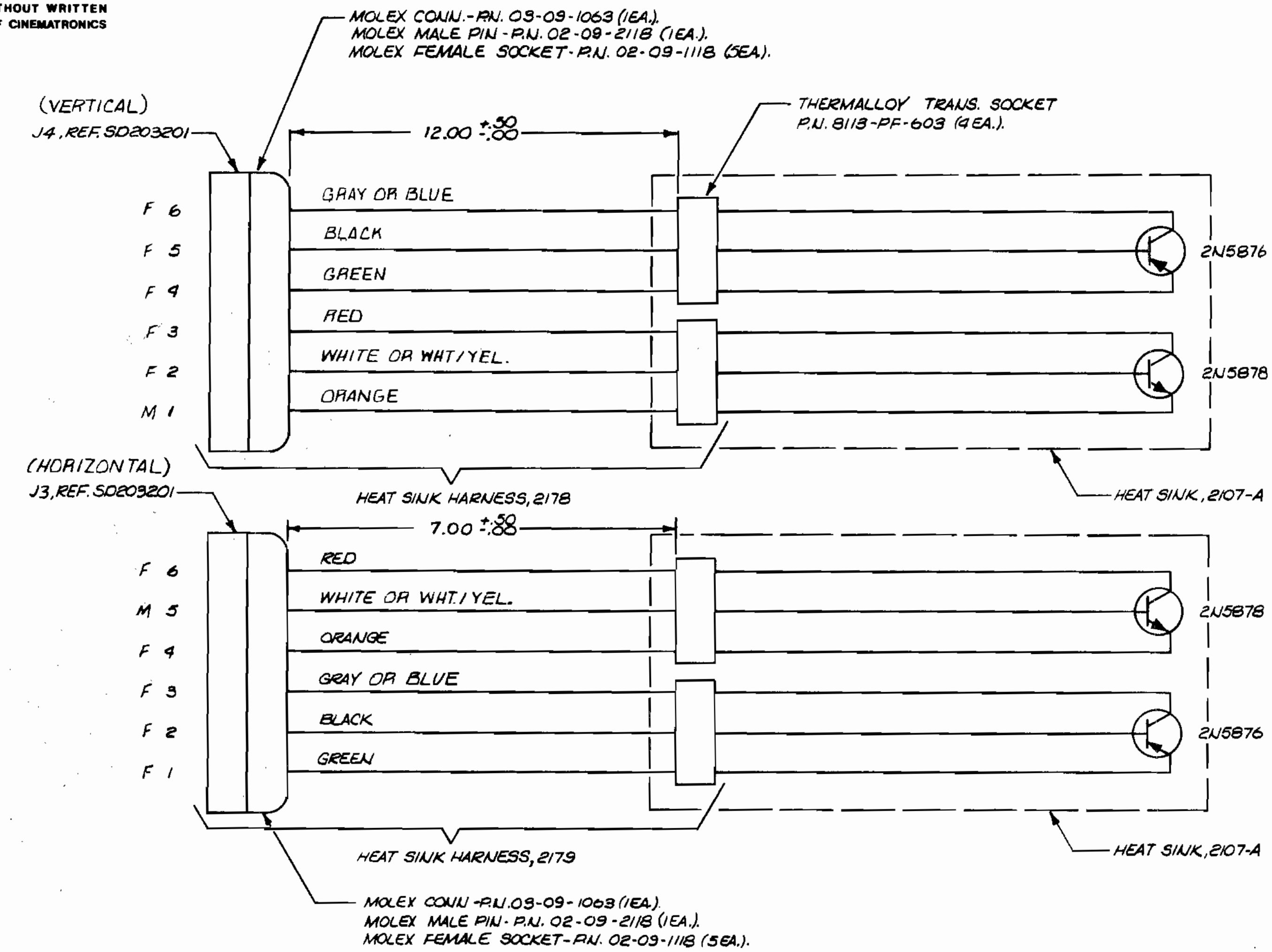




DISPLAY P.C.B.

CONNECTORS AND ADJUSTMENTS

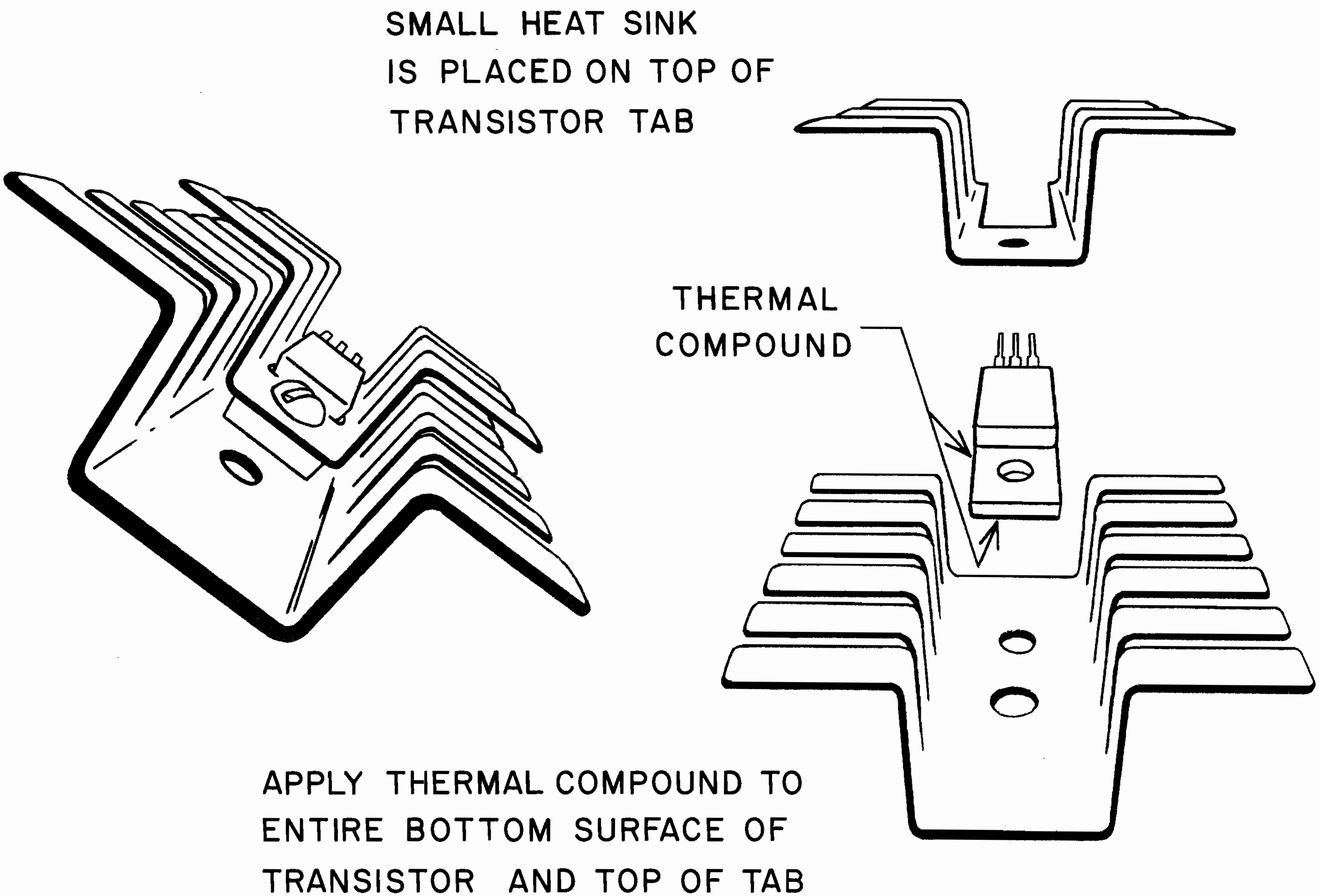
REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
B	PER ECR 058	9 MAY 80	

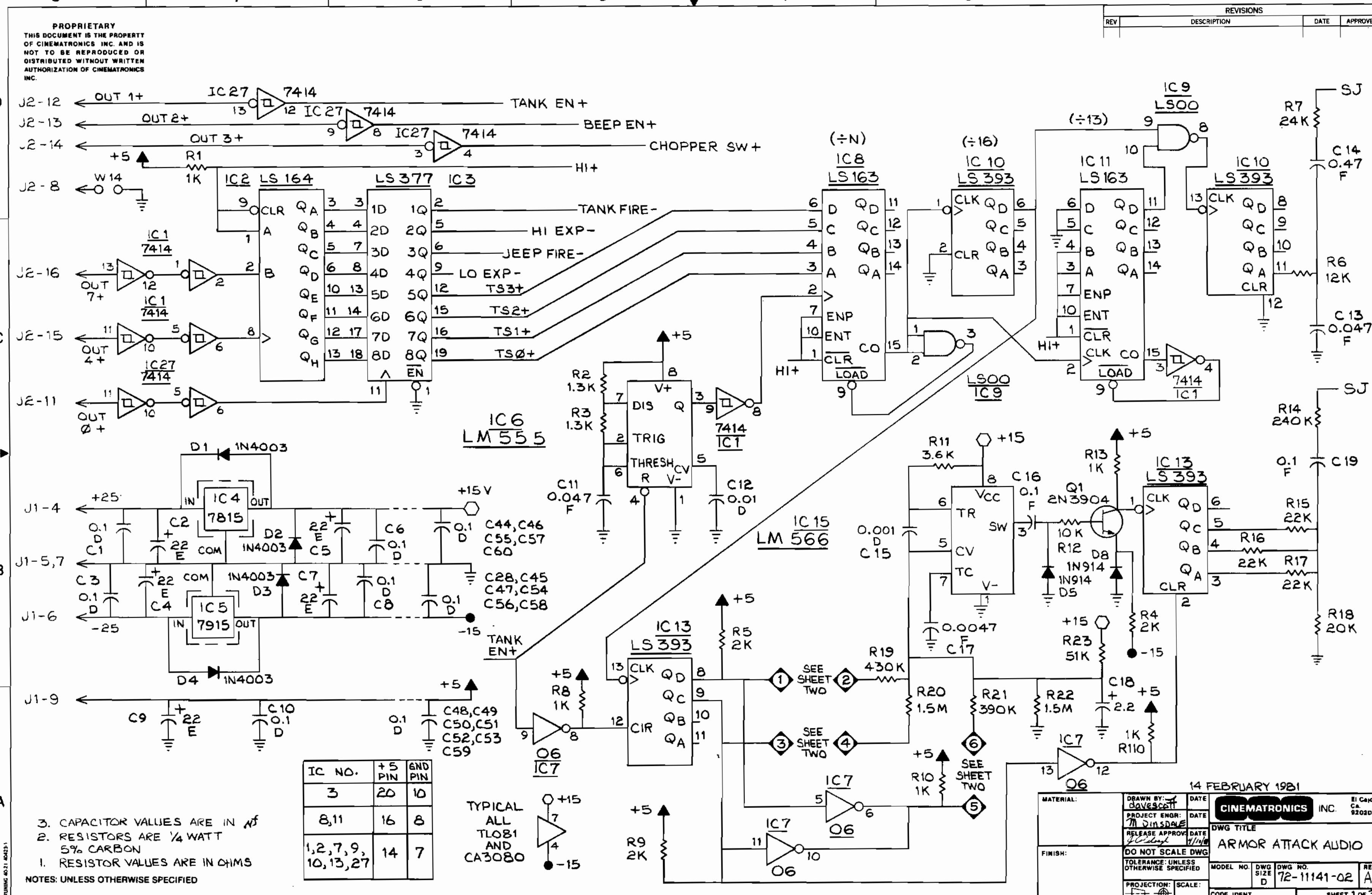


NOTES: UNLESS OTHERWISE SPECIFIED

MATERIAL:	DRAWN BY:	DATE 8-7-79	CINEMATRONICS INC. El Cajon Ca. 92020
	PROJECT ENGR:	DATE 8-79	
FINISH: BREAK ALL SHARP EDGES AND DEBURR ALL HOLES.	RELEASE APPROV:	DATE 8-79	DWG TITLE SCHEMATIC, VERTICAL & HORIZONTAL HEAT SINK ASSY.
	DO NOT SCALE DWG		
	TOLERANCE: UNLESS OTHERWISE SPECIFIED		MODEL NO. / DWG SIZE C / DWG NO. 72-10969-01 / REV. B
	PROJECTION:	SCALE: NONE	CODE IDENT. / SHEET / OF /

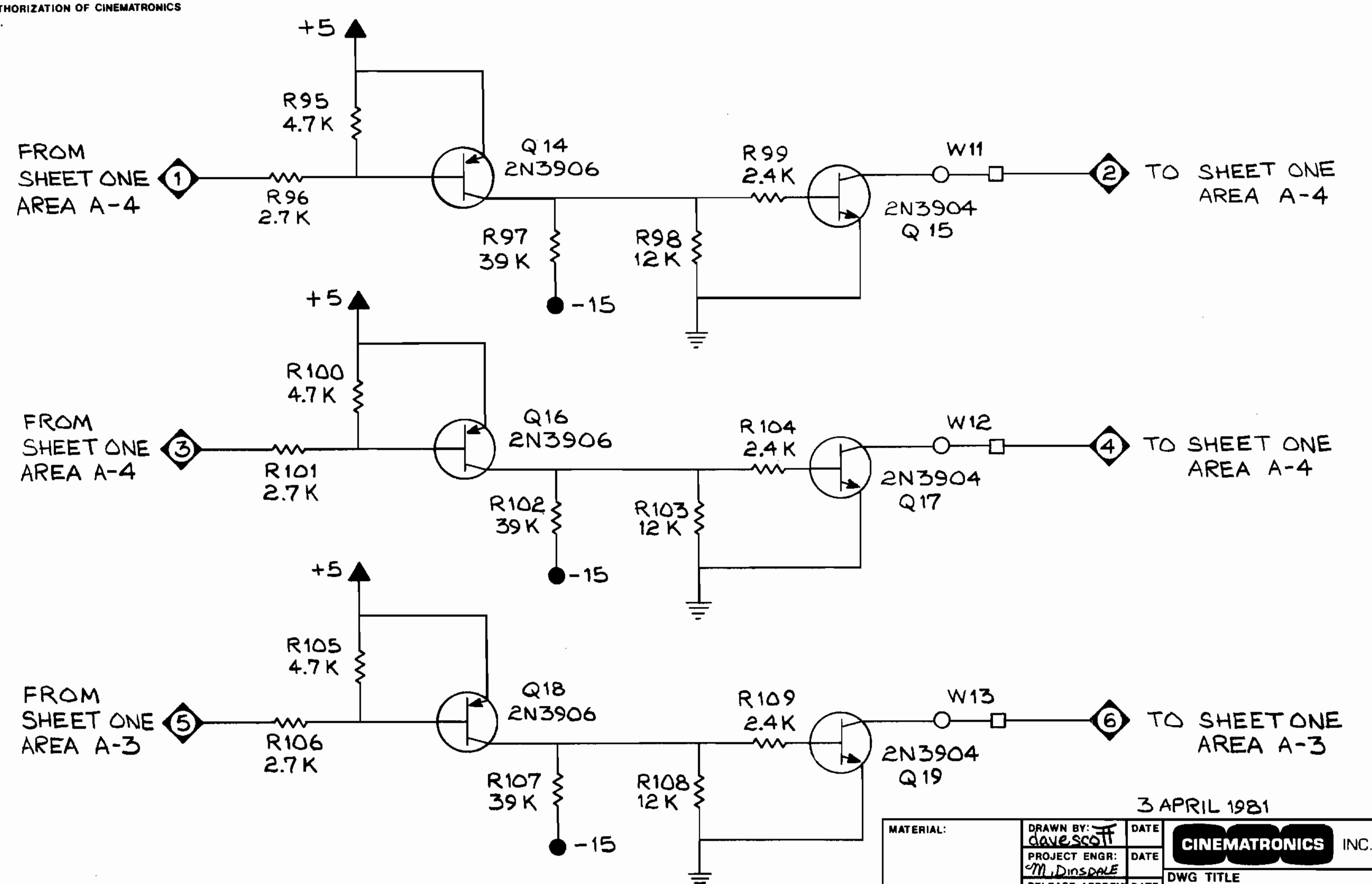
BRUNING 40-21 40423


SMALL HEAT SINK
IS PLACED ON TOP OF
TRANSISTOR TAB
THERMAL
COMPOUND
APPLY THERMAL COMPOUND TO
ENTIRE BOTTOM SURFACE OF
TRANSISTOR AND TOP OF TAB



IC NO.	+5 PIN	GND PIN
3	20	10
8,11	16	8
1,2,7,9,10,13,27	14	7

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

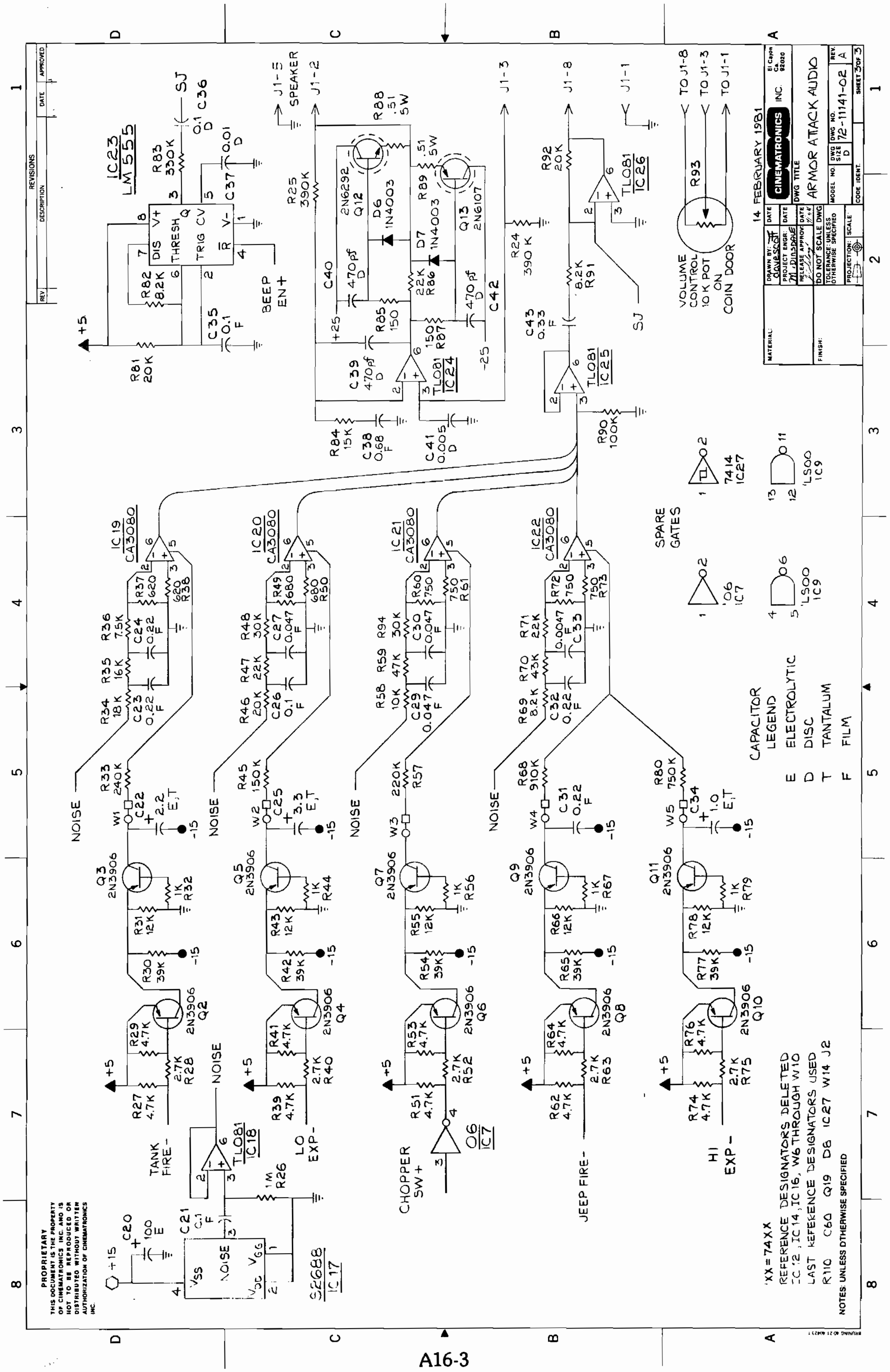


3 APRIL 1981

MATERIAL:	DRAWN BY: dave scott	DATE	CINEMATRONICS INC. El Cajon Ca. 92020
	PROJECT ENGR: M. Dinsdale	DATE	DWG TITLE
	RELEASE APPROV: J. Cl...	DATE 4/10/81	ARMOR ATTACK AUDIO
FINISH:	DO NOT SCALE DWG		MODEL NO. / DWG SIZE C / DWG NO. 72-11141-02 / REV. A
	TOLERANCE: UNLESS OTHERWISE SPECIFIED		
	PROJECTION:	SCALE:	CODE IDENT. / SHEET 2 OF 3

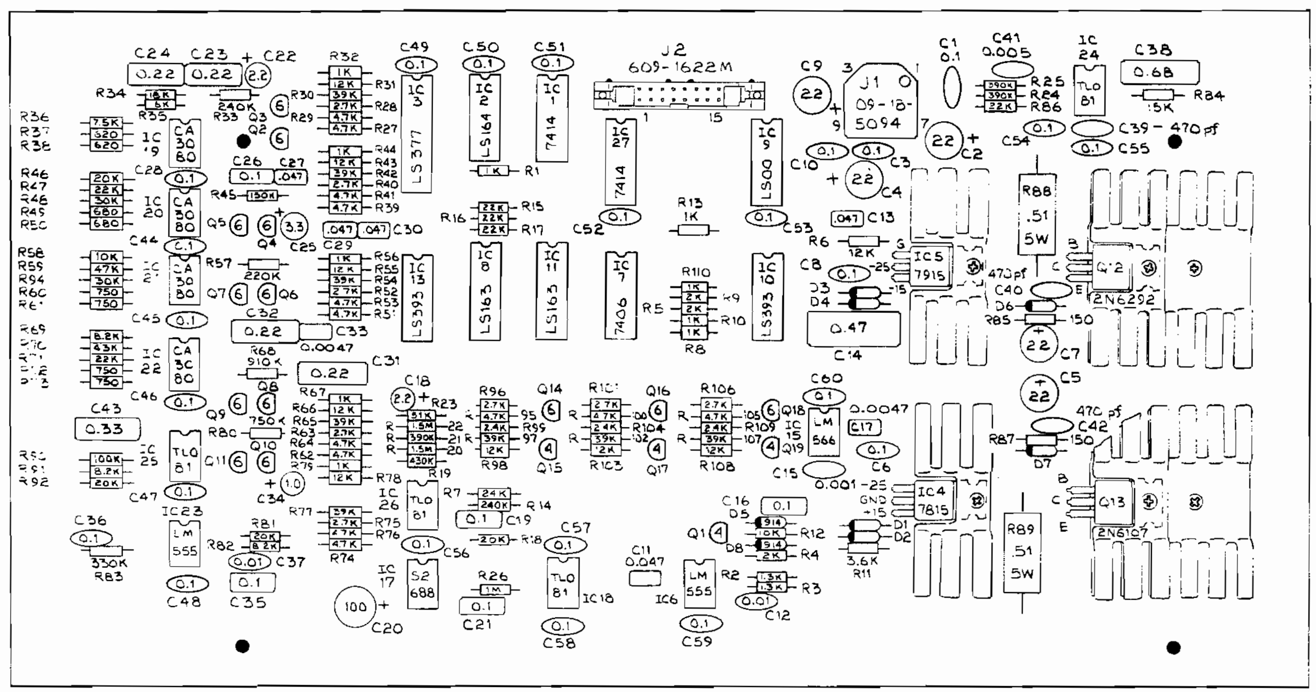
NOTES: UNLESS OTHERWISE SPECIFIED

BRUNING 40-21 40423-1


CINEMATRONICS INC.
El Cajon Ca. 92020
DWG TITLE
ARMOR ATTACK AUDIO
72-11141-02
SHEET 3 OF 3
14 FEBRUARY 1981
REVISIONS
PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF CINEMATRONICS INC. AND IS NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF CINEMATRONICS INC.
NOTES: UNLESS OTHERWISE SPECIFIED
'XX = 74XX
REFERENCE DESIGNATORS DELETED IC 12, IC 14, IC 16, W6 THROUGH W10
LAST REFERENCE DESIGNATORS USED R110 C60 Q19 D8 IC27 W14 J2
CAPACITOR LEGEND
E ELECTROLYTIC
D DISC
T TANTALUM
F FILM
SPARE GATES
VOLUME CONTROL 10 K POT ON COIN DOOR
TO J1-8
TO J1-3
TO J1-1
J1-5 SPEAKER
J1-2
J1-3
J1-8
J1-1
IC23 LM555
BEEP EN+
TANK FIRE-
LO EXP-
CHOPPER SW+
JEEP FIRE-
HI EXP-
NOISE
S2688 IC17
IC19 CA3080
IC20 CA3080
IC21 CA3080
IC22 CA3080
TL081 IC18
TL081 IC24
TL081 IC25
TL081 IC26
2N6292 Q12
2N6107 Q13
R93

PROPRIETARY
THIS DOCUMENT IS THE PROPERTY OF CINEMATRONICS INC. AND IS NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT WRITTEN AUTHORIZATION OF CINEMATRONICS INC.

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED



9 ◯ ELECTROLYTIC CAPACITOR
8 ▭ FILM CAPACITOR
7 ⬭ DISC CAPACITOR
6 ⑥ 2N3906
5 ④ 2N3904
4 1N914
3 1N4003
2 ALL CAPACITOR VALUES ARE IN MICRO FARADS, 50 V
1 ALL RESISTORS ARE IN OHMS, 1/4 W, 5% CARBON
NOTES: UNLESS OTHERWISE SPECIFIED

MATERIAL:	DRAWN BY dave scott	DATE 6 APRIL 1981	CINEMATRONICS INC El Cajon Ca 92020	
	PROJECT ENGR	DATE	DWG TITLE	
	RELEASE APPROV	DATE	ARMOR ATTACK AUDIO	
FINISH	DO NOT SCALE DWG			
	TOLERANCE UNLESS OTHERWISE SPECIFIED		MODEL NO. / DWG SIZE D / DWG NO. 72-11141-01	REV. 4
	PROJECTION	SCALE 2:1	CODE IDENT	SHEET 1 OF 1